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NAVIGATION CONDITIONS AT OLIVER LOCK AND DAM BLACK WARRIOR RIVER PROJECT

Hydraulic Model Investigation

by

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

William Bacon Oliver Lock and Dam is located on the left descending bank of the Black Warrior River about 346.3 river miles above Mobile, AL, in the corporate limits of Tuscaloosa, AL. The principal existing structures are a 700-ft-long fixed-crest spillway and a 95- by 460-ft lock. The dam forms a run of the river pool that extends 8.8 miles upstream to Holt Lock and Dam. During high pool elevation and river discharges, tows bypass the lock and navigate over the fixed-crest weir. Oliver Lock has the smallest chamber (95 by 460 ft) on the Black Warrior-Tombigbee Waterway, and the present plan of development is to replace the existing lock and dam with a new structure located about 2,300 ft downstream. The replacement structure will provide a 110- by 600-ft lock chamber and an 815-ft-long fixed-crest spillway. A fixed-bed model reproduced about 2.8 miles of

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19. ABSTRACT (Continued).

the Black Warrior River channel and adjacent overbank area to an undistorted scale of 1:100.

The model investigation was concerned with determining the effects of the proposed structures on navigation through the reach; developing modifications that could be used to improve navigation conditions; establishing the limits for removal of the existing structure; evaluating navigation conditions for tows entering and leaving the lock and approaching the fixed-crest dam with rising, falling, and design headwater rating curves; investigating the effects of the completed project, first-stage cofferdam, and second-stage cofferdam on water-surface slopes through the reach; and investigating the effects on navigation during the construction stages of the project and developing modifications necessary to maintain safe navigation through the reach. Results of the investigation indicated that satisfactory navigation conditions can be established through the reach with all flows tested; however, with higher riverflows and current velocities, certain maneuvers may be required for downbound tows to approach the lock. With the higher riverflows, the alignment of the currents was satisfactory for upbound and downbound tows to approach the fixed-crest dam; however, the drop across the dam could create some difficulties and require considerable power for tows to navigate over the dam. With the first-stage cofferdam in place for construction of the replacement lock, considerable power and maneuvering could be required for upbound tows to move past the cofferdam with riverflows of 30,000 cfs and above. With the second-stage cofferdam in place, a training structure placed in the vicinity of the lower lock approach of the replacement lock will provide satisfactory conditions for tows entering and leaving the lower lock canal with riverflows through 100,000 cfs.

PREFACE

The model investigation herein described was conducted for the US Army Engineer District, Mobile, by the US Army Engineer Waterways Experiment Station (WES), Vicksburg, MS. The study was conducted in the Hydraulics Laboratory of WES during the period July 1984 to July 1987.

During the course of the model study, representatives of Mobile District and other navigation interests visited WES at different times to observe special model tests and to discuss test results. The Mobile District was kept informed of the progress of the study through monthly progress reports and special reports at the end of each test.

The model study was conducted under the general supervision of Messrs. F. A. Herrmann, Jr., Chief of the Hydraulics Laboratory, and R. A. Sager, Assistant Chief of the Hydraulics Laboratory; and under the direct supervision of Messrs. J. E. Glover, former Chief of the Waterways Division; M. B. Boyd, present Chief of the Waterways Division; L. J. Shows and Ms. C. M. Holmes, former Chiefs of the Navigation Branch; and Dr. L. L. Daggett, present Chief of the Navigation Branch. The principal investigators in immediate charge of the model study were MAJ Joe Miller and Mr. R. T. Wooley, assisted by Messrs. H. E. Park, E. Johnson, E. A. Frost, and J. W. Sullivan, and Ms. D. P. George, all of the Navigation Branch. This report was prepared by Mr. R. T. Wooley and edited by Mrs. M. C. Gay, Information Technology Laboratory, WES.

Acting Commander and Director of WES during preparation of this report was LTC Jack R. Stephens, EN. Technical Director was Dr. Robert W. Whalin.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic metres
degrees (angle)	0.01745329	radians
feet	0.3048	metres
miles (US statute)	1.609344	kilometres
square miles	2.589998	square kilometres

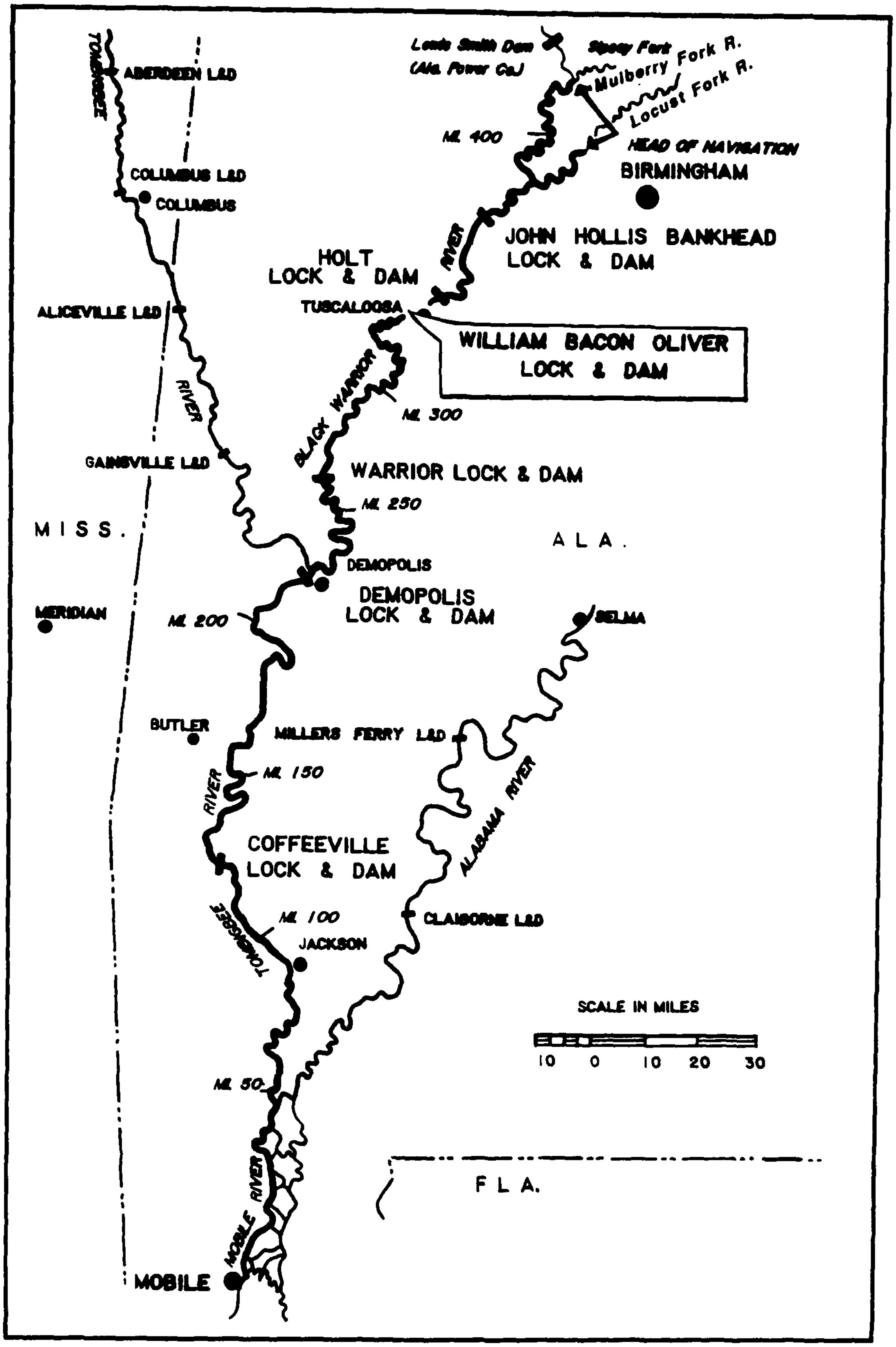

Figure 1. Location map

NAVIGATION CONDITIONS AT OLIVER LOCK AND DAM

BLACK WARRIOR RIVER PROJECT

Hydraulic Model Investigation

PART I: INTRODUCTION

Location and Description of Prototype

1. William Bacon Oliver Lock and Dam is located on the left descending bank of the Black Warrior River 346.3 river miles above Mobile, AL, in the corporate limits of Tuscaloosa, AL (Figure 1). The principal existing structures are a 700-ft-long* fixed-crest spillway and a 95- by 460-ft lock. The dam forms a run of the river pool that extends 8.8 miles upstream to Holt Lock and Dam. During high pool elevations and river discharges, tows bypass the lock and navigate over the fixed-crest weir.

2. The Black Warrior River is formed by the confluence of the Mulberry Fork and the Locust Fork rivers approximately 20 miles west of Birmingham, AL, and flows southwestward approximately 165 river miles to its confluence with the Tombigbee River near Demopolis, AL. The river above Oliver Lock and Dam drains an area of about 4,800 square miles.

3. Presently on the Black Warrior-Tombigbee river system there are six lock and dam structures that connect Mobile, AL, to the uppermost part of Black Warrior River. From north to south these locks are Bankhead, Holt, Oliver, Warrior, Demopolis, and Coffeeville. Oliver Lock and Dam is located 8.8 miles downstream of Holt Lock and Dam and 76.7 miles upstream of Warrior Lock and Dam.

History of Project

4. The construction of the existing Oliver Lock and Dam was authorized in 1935, and the lock was open to traffic in August 1939. Subsequent to the construction of Oliver Lock and Dam, a larger lock chamber (110 by 600 ft) was

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* A table of factors for converting non-SI units of measurement to SI (metric) units is found on page 3.

authorized for all new locks being built on the waterway; therefore, Oliver Lock and Dam has the smallest chamber (95 by 460 ft) on the waterway. This size chamber is capable of locking through four standard-sized barges and a towboat in a single lift. The six-barge tow now being used on the waterway experiences significant delays at Oliver, since it must be broken apart and locked through in two sections. The use of the six-barge tow has rendered Oliver Lock obsolete and has necessitated its replacement with a larger lock.

Present Development Plan

5. The present plan consists of a new lock and dam located approximately 2,300 ft downstream of the existing lock and dam. The replacement lock (110 ft wide by 600 ft long) will be constructed in the right bank with the necessary entrance and exit channels. A new 815-ft-long fixed-crest spillway with a crest elevation of 123.0* will be constructed adjacent to the new lock. A portion of the existing spillway will be removed to provide navigation depth over the existing dam.

6. The proposed lock and dam will be constructed in two stages. During the first stage, the new lock and about one-half of the new fixed-crest weir will be constructed in the first-stage cofferdam and tows will lock through the existing structure and navigate past the cofferdam. During the second stage, the remainder of the new fixed-crest spillway will be constructed in the second-stage cofferdam and 330 ft of the new fixed-crest spillway will be used to pass flow and maintain a navigation pool.

Need for and Purpose of Model Study

7. Although the design of the proposed lock and dam was based on sound theoretical design practice and experience, conditions through the reach could be expected to be extremely complex. This could be attributed to the currents in the vicinity of the lock, irregular channel alignments and configurations, limited channel width, crosscurrents, and high velocities. Navigation conditions vary with location and flow conditions upstream and downstream of a

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* All elevations (el) cited herein are in feet referred to the National Geodetic Vertical Datum (NGVD).

structure, and an analytical study to determine the hydraulic effects expected to result from a particular design is both difficult and inconclusive. Therefore the comprehensive model study was considered necessary to

a. Determine the effects of the proposed structures on navigation through the reach.

b. Develop modifications that could be used to improve navigation conditions.

c. Establish the limits for removal of the existing structure.

d. Evaluate navigation conditions for tows entering and leaving the lock and approaching the fixed-crest dam with rising, falling, and design headwater rating curves.

e. Investigate the effects of the completed project, first-stage cofferdam, and second-stage cofferdam on water-surface slopes through the reach.

f. Investigate the effects on navigation during the construction stages of the project and develop modifications necessary to maintain safe navigation through the reach.

8. The model was also used to demonstrate for the design engineers and navigation interests the conditions resulting from the proposed design, and to satisfy these interests of the design's acceptability from a navigation standpoint.

PART II: THE MODEL

Description

9. The model reproduced about 2.8 miles of the Black Warrior River and the adjacent overbank areas from about 7,100 ft upstream to about 7,700 ft downstream of the existing Oliver Dam. The model was of the fixed-bed type with overbank areas and channels molded of sand cement mortar to sheet metal templates set to the proper grade. Portions of the model where changes in bank alignments and channel configurations could be anticipated were molded of pea gravel to facilitate modifications necessary to develop satisfactory navigation conditions. The lock, guide walls, guard walls, and fixed-crest spillways were constructed of sheet metal and set at the proper grade. The channel portion of the the model was molded to conform to a hydrographic survey dated August 1982, and the overbanks were molded to a topographic survey dated 13 December 1982.

Scale Relations

10. The model was built to an undistorted linear scale of 1:100, model to prototype. This scale allows accurate reproduction of velocities, eddies, and crosscurrents that would affect navigation. Other scale ratios resulting from the linear scale ratio are as follows:

Characteristic	Scale Relation Model:Prototype
Area	1:10,000
Velocity	1:10
Time	1:10
Discharge	1:100,000
Roughness (Manning's n)	1:2.15

Measurements of discharge, current velocities, and water-surface elevations can be quantitatively transferred from model to prototype by means of these scale relations.

Appurtenances

11. Water was supplied to the model by a 10-cfs pump operating in a circulating system. The discharge was controlled and measured by a valve and a venturi meter. Water-surface elevations were measured by piezometer gages located in the model channel and connected to a centrally located gage pit. At the lower end of the model a tailgate was provided to control the established tailwater elevations for the discharge tested.

12. Velocities and current directions were measured in the model by cylindrical wooden floats submerged to the depth of a loaded barge (8.0 ft prototype). Confetti was also used to determine surface current directions. A radio-controlled model towboat and barges were used to determine and demonstrate the effects of currents on tows approaching and leaving the lock and in the critical reaches of the project. The towboat was equipped with twin screws and was propelled by two small electric motors operating with a battery in the tow. The speed and the rudders of the tow were remote-controlled, and the towboat could be operated in forward and reverse at speeds comparable to those that could be expected to be used by the towboats on the Black Warrior-Tombigbee waterway.

Model Adjustments

13. The surface of the model was constructed of brushed cement mortar to provide a roughness (Manning's n) of about 0.0135, which corresponds to a roughness in the prototype of about 0.029. With the existing lock and fixed-crest spillway in place, the model was checked against available prototype data and the constant discharge design tailwater and headwater rating curves. The results indicated that the model reproduced with a reasonable degree of accuracy conditions in the prototype based on the available data.

PART III: TESTS AND RESULTS FOR COMPLETED PROJECT

14. The primary concerns of the tests were the study of flow patterns, measurement of velocities and water-surface elevations, and effects of currents on the movement of the model tow approaching and leaving the existing lock and replacement lock. These conditions were studied with the completed project and during the first- and second-stage cofferdam plans.

Test Procedures

15. A selection of representative flows were used for testing based on information furnished by the US Army Engineer District, Mobile, as shown in the following tabulation:

Riverflow cfs	Tailwater El
30,000	114.0
60,000	126.0
100,000	136.5
130,000	141.5
160,000	145.0
198,000	148.0

The final plan was evaluated with lower and higher tailwater elevations to represent tailwater elevations that could be experienced during rising and falling stages.

16. The riverflows were reproduced by introducing the proper discharge and manipulating the tailgate until the required tailwater elevation was obtained. During the base test, the tailwater was controlled at Gage 4A to settings obtained from the discharge rating curve supplied by the Mobile District. For subsequent tests the tailwater was controlled at Gage 10 to elevations obtained during the base test.

17. Current directions were determined by plotting the path of floats with respect to ranges established for that purpose, and velocities were measured by timing the travel of floats over measured distances. In the interest of clarity, in the case of plots of currents in turbulent areas or where eddies or crosscurrents existed, only the main trends are shown. A model tow representing a six-barge tow drafting 8 ft was used to evaluate and

demonstrate navigation conditions for tows moving through the model reach. A model tow representing a four-barge tow was used to evaluate navigation conditions with existing conditions and some of the cofferdam tests. Multiple-exposure time-lapse photography was used to record the path of the model tow navigating the model reach.

Base Tests

Description

18. Base tests were conducted with the model reproducing existing conditions as shown in Figure 2. The purposes of the tests were to verify that the model was reproducing known prototype conditions and to provide information and data that could be used to evaluate the effect of the proposed modifications on water-surface elevations, current direction and velocities, and navigation conditions. The principal features reproduced or simulated in the model, shown in Figures 2 and 3, included:

- a. A lock with clear chamber dimensions of 95 by 460 ft (top of walls at el 140) located along the left descending bank at about river mile 338.1 with a 350-ft-long, ported, upper guard wall (top of ports el 113.0) and a 430-ft solid, landward, lower guide wall.
- b. A 700-ft fixed-crest dam adjacent to the lock with a crest el of 122.9.
- c. A 129-ft abutment adjacent to the fixed-crest dam.
- d. The GM & O Railroad bridge, with a 275-ft navigation span, located about 3,000 ft upstream of the dam axis.
- e. The Highway 43 bridge, with a 248-ft navigation span, located about 4,000 ft upstream of the dam axis.

Results

19. Water-surface elevations. Water-surface elevations obtained with existing conditions (Table 1) indicated the average slope in the model upstream of the dam (Gages 1-3) ranged from about 0.1 to 0.9 ft per mile and downstream of the dam (Gages 4A-10), from about 0.2 to 0.7 ft per mile with riverflows ranging from 30,000 to 198,000 cfs. The drop across the fixed-crest dam (Gages 3 and 4) ranged from about 14.9 to 2.1 ft with riverflows ranging from 30,000 to 198,000 cfs.

20. Current directions and velocities. Data shown in Plates 1-5 indicated the currents upstream of the dam were generally parallel to the left

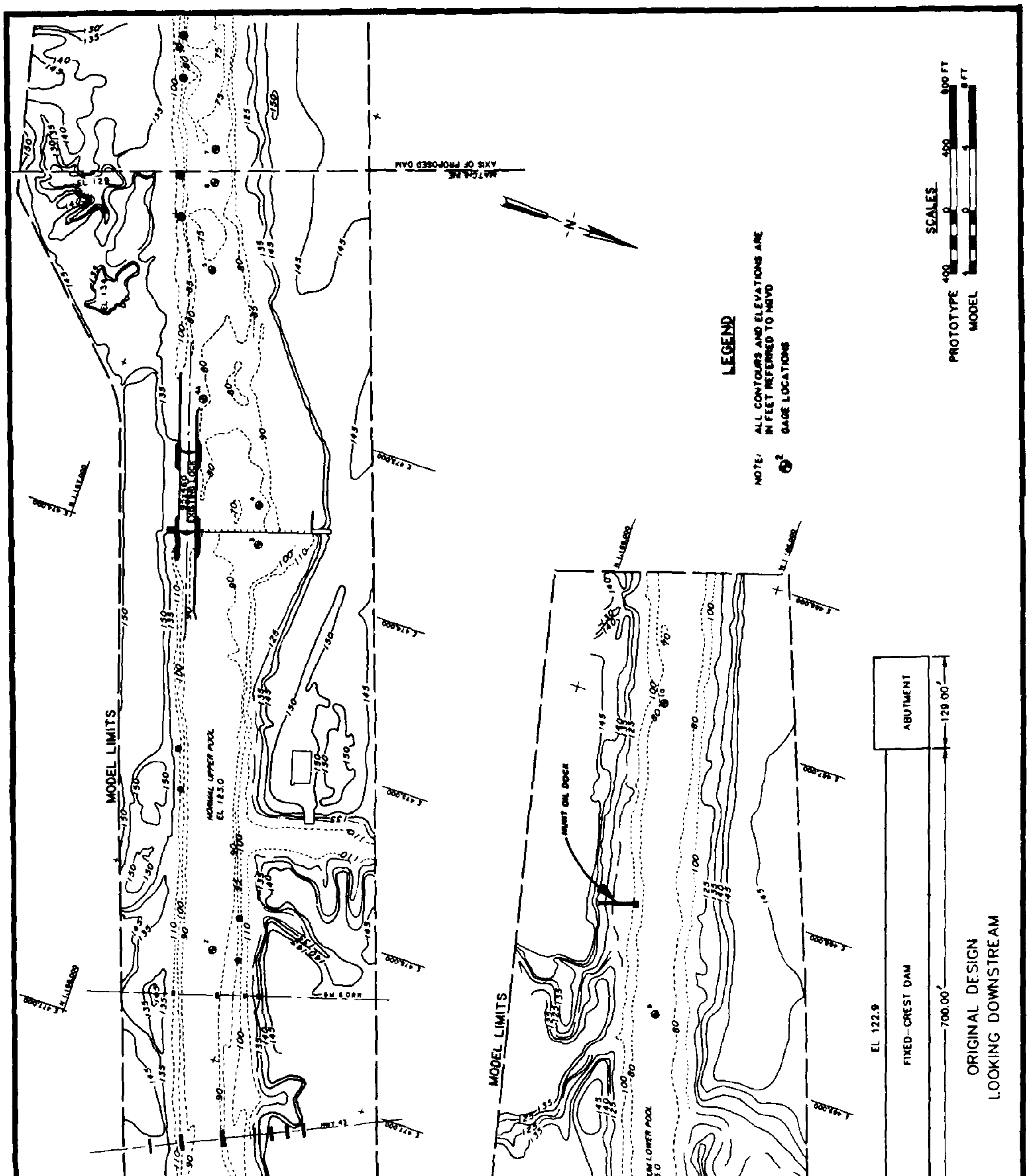


Figure 2. Existing conditions

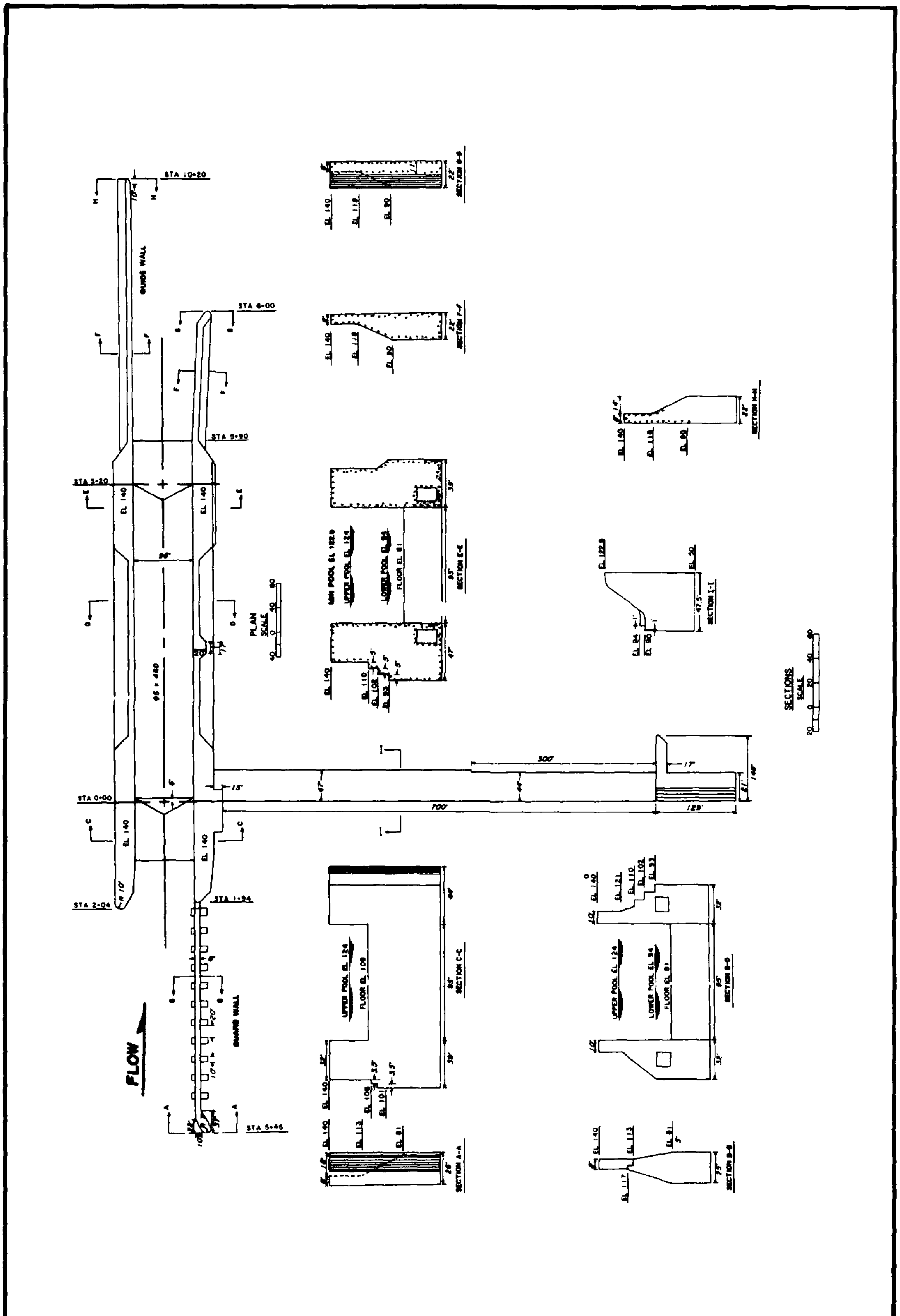


Figure 3. General plan and section, existing structure

bank from upstream of the bridges to about 400 ft upstream of the upper guard wall of the lock and then moved toward the right bank and the dam. The currents immediately downstream of the dam were directed toward the lower approach of the lock with the currents downstream of the lock being generally parallel to the bank lines. The maximum velocity of the currents in the navigation channel upstream of the lock varied from about 2.5 to 7.5 fps through the bridges and 2.2 to 7.7 fps about 1,000 ft upstream of the lock with the 30,000- and 160,000-cfs flows, respectively. The maximum velocity of the currents in the navigation channel downstream of the dam varied from 3.7 to 7.3 fps near the downstream end of the landward guide wall and from 2.7 to 7.5 fps about 5,800 ft downstream of the dam with the 30,000- and 160,000-cfs flows, respectively.

21. Navigation conditions. Model tests conducted with a 70-ft-wide by 480-ft-long tow representing four 35- by 195-ft barges with a 100-ft pusher indicated the model was reproducing navigation conditions that were comparable to existing prototype conditions. The navigation spans of the bridges in relation to the lock were aligned so that downbound tows could move through the bridges and enter the lock without any major difficulties.

Plan A

Description

22. Plan A involved removing a major portion of the existing fixed-crest dam and placing a 110- by 600-ft lock and an 815-ft fixed-crest dam about 2,300 ft downstream of the existing dam (Figures 4 and 5). The axis of the dam was located at river mile 337.6, and the intersection of the center line of the lock and the pintle of the upper lock gate was located at coordinates N 1,167,585, E 471,511. Features of this plan concerning the elevation and amount of existing dam to be removed and the limits of the left bank excavation in the vicinity of the new dam were developed during preliminary tests and construction sequence tests. The principal features of Plan A were as follows (Figures 4 and 5):

a. The existing fixed-crest dam and right bank abutment were removed to el 95.0 except for the 250 ft of dam adjacent to the existing lock, which was removed to el 111.0 (12 ft below minimum pool).

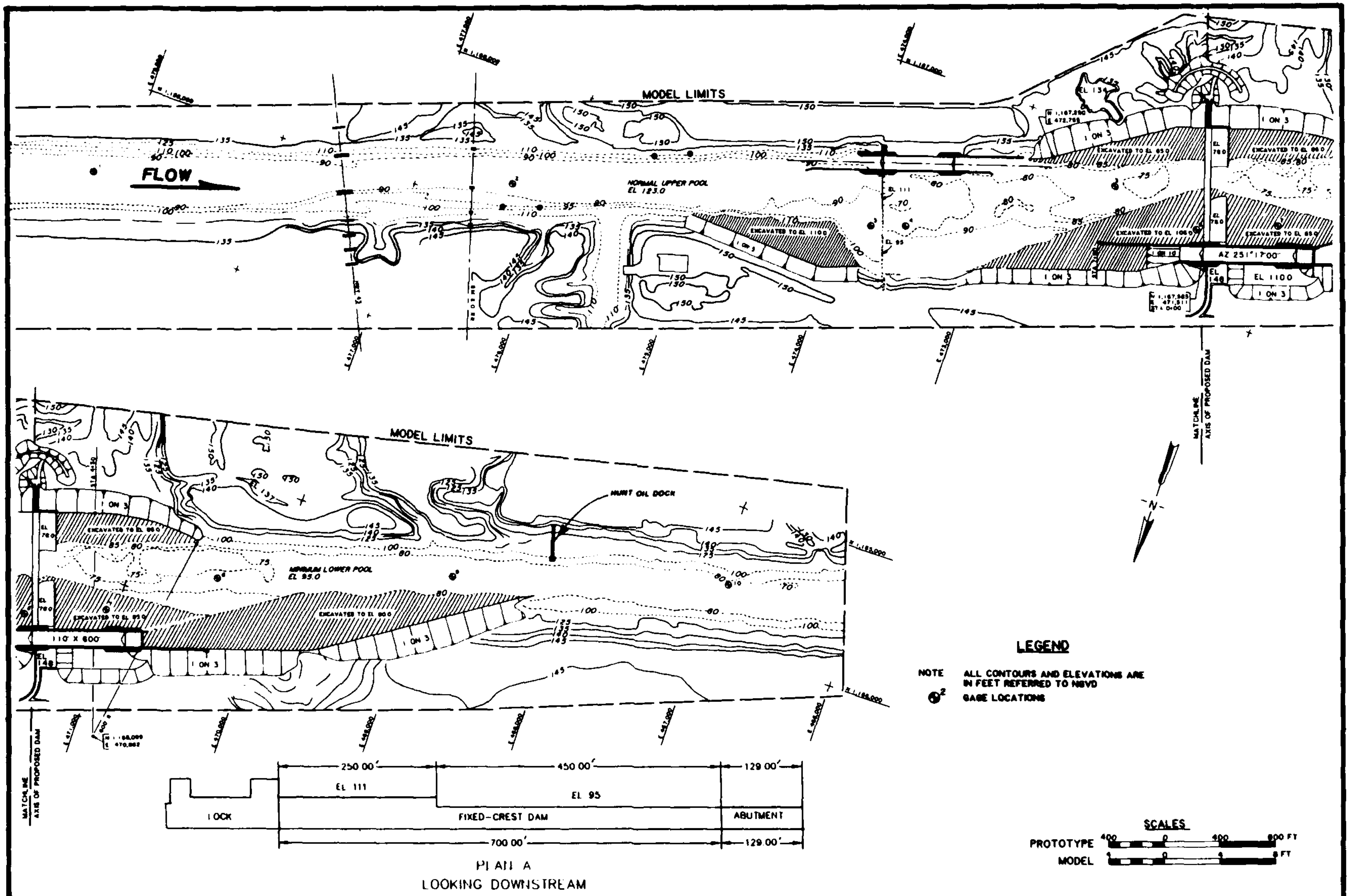


Figure 4. Plan A

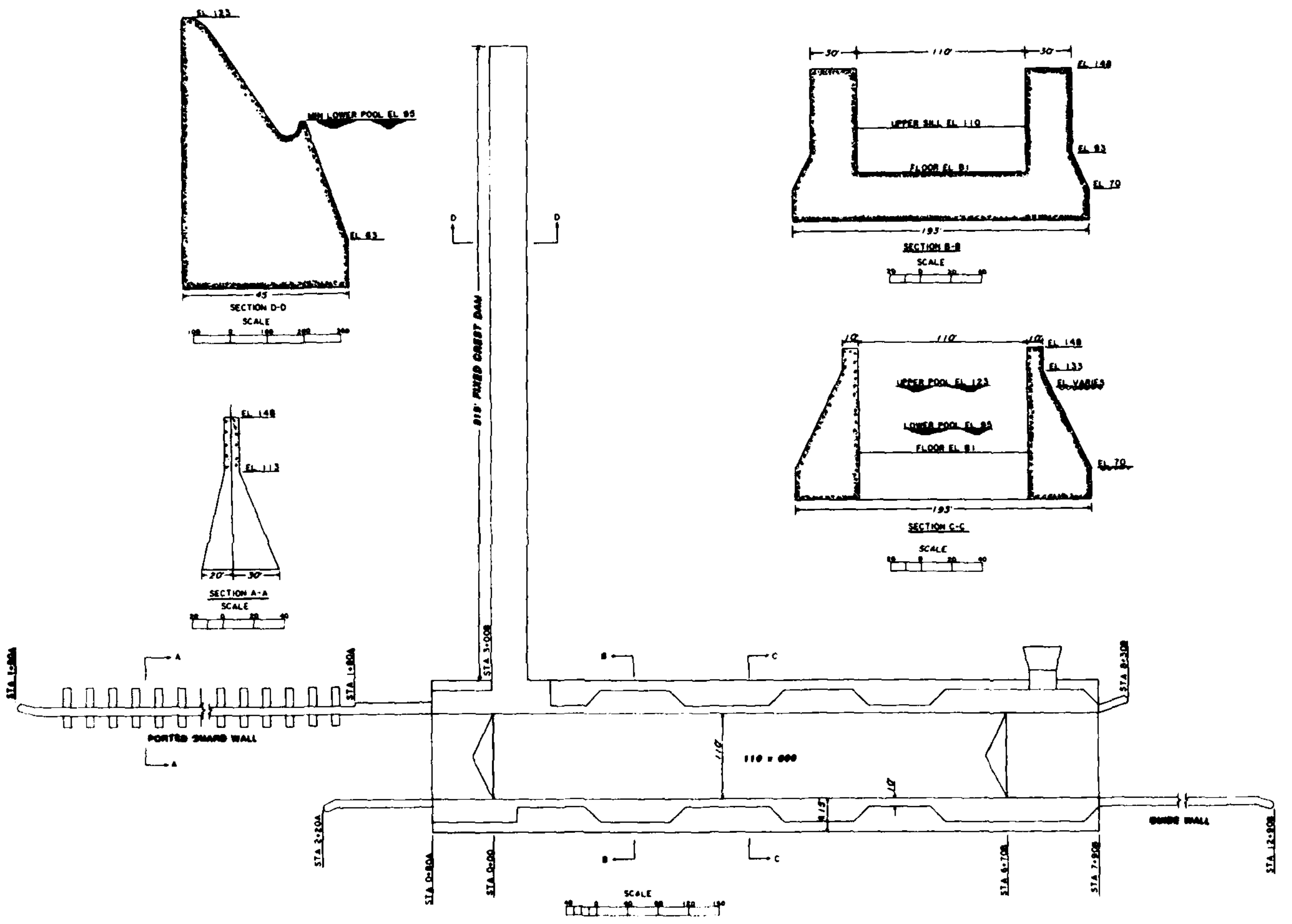


Figure 5. General plan and section of proposed structure

b. A lock with clear chamber dimension of 110 by 600 ft was placed adjacent to the right bank about 2,300 ft downstream of the existing dam.

c. A 600-ft-long ported upper guard wall with eighteen 20-ft-wide ports with the top of ports at el 121.0 was added.

d. A 500-ft-long solid lower guide wall was added.

e. An 815-ft fixed-crest dam with crest el 123.0 was placed adjacent to the lock.

f. A nonoverflow, left bank abutment was added adjacent to the spillway.

g. The right bank upstream of the existing dam was excavated to el 110.0, the maximum distance landward that would not encroach on the existing access road.

h. The right bank and channel bottom upstream of the new lock and the right end of the dam were excavated to el 106.0 and the channel bottom downstream of the dam to el 85.0.

i. The right bank downstream of the new lock was excavated to el 80.0.

j. The left bank upstream and downstream of the left end of the new dam was excavated to el 85.0 (the limits of the left bank excavation were developed during first-stage cofferdam tests to provide satisfactory navigation conditions during construction).

Results

23. Two operational procedures were evaluated with Plan A conditions: existing lock gates closed and existing lock gates open to pass flow through the lock chamber. Model data were obtained with both operational procedures of the existing lock.

24. Water-surface elevations. Water-surface elevations obtained with Plan A (Table 2) indicated opening or closing the gates of the existing lock had no appreciable effect on water-surface elevations. The new fixed-crest dam created a navigation pool beginning at river mile 337.6, significantly changing the water-surface elevations from the new structure upstream to the existing structure. However, there was no significant change in the water-surface slope per mile through the model reach compared to the base test. The slope in water-surface elevations varied from less than 0.1 to about 0.9 ft per mile upstream of the dam and from about 0.2 to 0.7 ft per mile downstream of the dam. The drop across the fixed-crest dam ranged from about 14.5 to 1.3 ft with riverflows ranging from 30,000 to 198,000 cfs.

25. Current directions and velocities. Data obtained with the gates of

the existing lock closed (Plates 6-10 and Photos 1 and 2) indicate the currents upstream of the lock were generally parallel to the bank lines from upstream of the bridges to the upstream end of the right bank excavation (about 3,600 ft upstream of the new dam axis), then moved toward the right bank and into the approach to the new lock. The currents approaching the replacement lock moved into the right bank excavation about 2,500 ft upstream of the guard wall and then turned toward the dam about 1,000 ft upstream of the guard wall. The currents near the downstream end of the lock moved toward the right bank and across the lower lock approach and then at about 2,500 ft downstream of the dam became generally aligned with the right bank (Photos 3 and 4). The maximum velocity in the navigation channel upstream of the lock varied from about 2.4 to 7.3 fps through the bridges, 2.5 to 7.7 fps near the upstream end of the right bank excavation, and 2.3 to 6.7 fps about 1,000 ft upstream of the guard wall with the 30,000- and 160,000-cfs riverflows, respectively. The maximum velocity in the lower lock approach near the downstream end of the guide wall varied from 1.9 to 4.7 fps with the 30,000- and 100,000-cfs riverflows, respectively, and the maximum velocity near the downstream end of the right bank excavation varied from about 2.8 to 6.3 fps with the 30,000- and 160,000-cfs riverflows, respectively.

26. Current direction and velocity data obtained with the gates of the existing lock open to pass flow through the lock chamber (Plates 11-13) indicate the alignment of the currents through the model reach were generally the same as with the gates closed. There was a slight improvement in the alignment of the currents immediately upstream of the guard wall and a slight decrease in the average velocity.

27. Navigation conditions. Locating the replacement lock immediately downstream of the existing structures and along the right bank will require downbound tows to move through the navigation spans of the highway and railroad bridges adjacent to the left bank, turn toward the right bank as quickly as possible, enter the right bank excavation, and turn toward the left to align with the replacement lock, all in a very limited distance. As the velocity of the currents increases, this maneuver becomes more difficult. With riverflows through 60,000 cfs, downbound tows could navigate through the center of the bridges, make the turn into the right bank excavation, align with the lock one to two tow lengths upstream of the guard wall, and reduce speed to approach the guard wall (Photos 5 and 6). As the riverflow increased

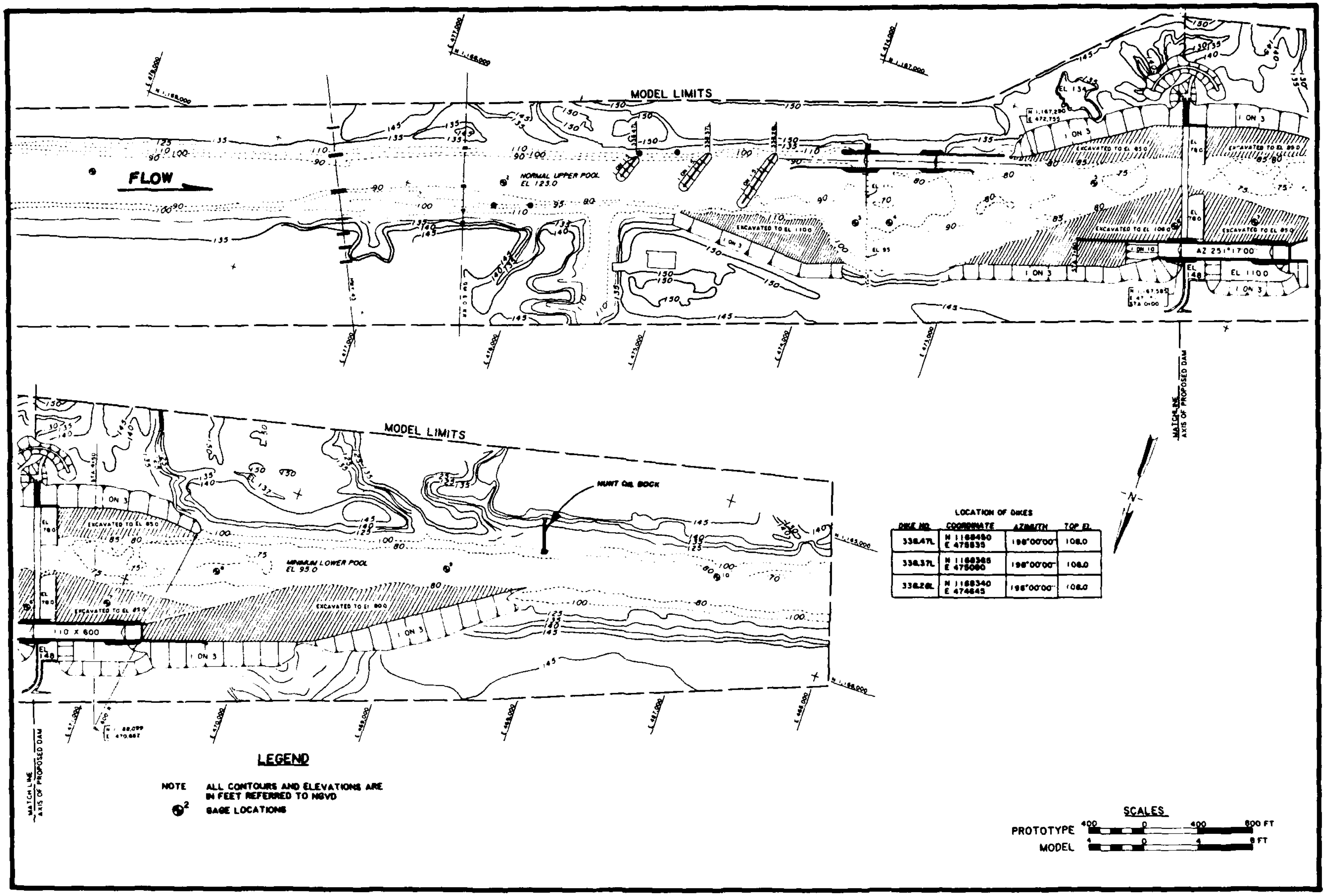
above 60,000 cfs and the velocity of the currents increased, it became more difficult to make the turn from the river channel into the right bank excavation and align with the lock. There was also a tendency for the currents to push the tow into the upstream guard wall of the existing lock as the tow attempted to make the turn into the right bank excavation. With a riverflow of 100,000 cfs, there was a tendency to misjudge the currents and either run aground on the right bank upstream of the new lock or miss the lock to the riverward side (Photo 7). However, a downbound tow could start a flanking maneuver as it cleared the bridges, flank toward the right bank, moving the tow into the right bank excavation well upstream of the lock, and let the tow move along the right bank into the lock approach (Photo 8). Considerable time could be required to perform the maneuver, but there was no indication of any major difficulties. No major difficulties were indicated for upbound tows leaving the lock (Photos 9-11).

28. Opening the gates of the existing lock to pass flow did not significantly change navigation conditions for tows entering or leaving the upper lock approach. Tows could also enter and leave the lower lock approach without any major difficulties. However, the Hunt Oil Dock located along the left bank near the downstream end of the lower approach to the lock did restrict the channel width in an area that a tow would be maneuvering to enter or leave the approach and could create some difficulties (Photos 12-17).

Plan A-Modified

Description

29. Plan A-Modified was the same as Plan A except three submerged dikes of various lengths with top el 108.0 were added in the main river channel at river miles 338.47, 338.37, and 338.28 (Figure 6). The dikes were connected to the left bank, spaced about 500 ft apart, and angled upstream to provide the most efficient training of the currents into the right bank excavation. The submerged dikes were developed to increase the flow into the excavation along the right bank upstream of the existing structure in an attempt to improve navigation conditions for tows turning from the main river channel into the right bank excavation. The gates in the existing lock were closed to aid in moving the currents toward the right bank.



LOCATION OF DIKES

DIKE NO.	COORDINATE	AZIMUTH	TOP EL
338.4TL	N 1168490 E 475835	198°00'00"	108.0
338.3TL	N 1168385 E 475080	198°00'00"	108.0
338.2BL	N 1168340 E 474645	198°00'00"	108.0

Figure 6. Plan A-Modified

Results

30. Water-surface elevations. Water-surface elevations obtained with Plan A-Modified (Table 3) indicate the submerged dikes increased the water-surface elevations upstream of the dikes (Gages 1 and 2). The increase in water-surface elevations ranged from about 0.1 to 0.3 ft with the 30,000- and 198,000-cfs flows, respectively. There was no significant change in the water-surface elevations downstream of the dikes.

31. Current directions and velocities. Data (Plates 14-16) indicate the submerged dikes moved more flow into the right bank excavation upstream of the existing lock and into the lock approach compared to Plan A. However, the currents moving across the lock approach near the upstream end of the guard wall also increased, thereby creating a severe outdraft at the upstream end of the guard wall with the 100,000-cfs riverflow. The velocity of the currents about 1,000 ft upstream of the guard wall increased slightly compared with Plan A with the maximum velocities ranging from 2.4 to 5.3 fps with the 30,000- and 100,000-cfs riverflows, respectively. The alignment and velocities of the currents downstream of the dam were generally the same as with Plan A.

32. Navigation conditions. With riverflows through 60,000 cfs, navigation conditions were generally the same as with Plan A except for a slight increase in the outdraft near the upstream end of the guard wall. With riverflows above 60,000 cfs, the submerged dikes did not reduce the maneuvering required for downbound tows to align with the lock. With a riverflow of 100,000 cfs, there was a tendency for a downbound tow, reducing speed to enter the lock forebay, to be moved toward the dam and riverward of the guard wall by the currents moving across the lock approach near the upstream end of the guard wall. There was no indication of any major difficulties for tows leaving the upper lock approach or for tows entering or leaving the lower lock approach.

Plan B

Description

33. Plan B (Figure 7) was the same as Plan A except for the following:

a. The right bank upstream of the existing dam was excavated landward to el 110.0 extending from the dam upstream to the creek (this excavation encroached on the existing access road).

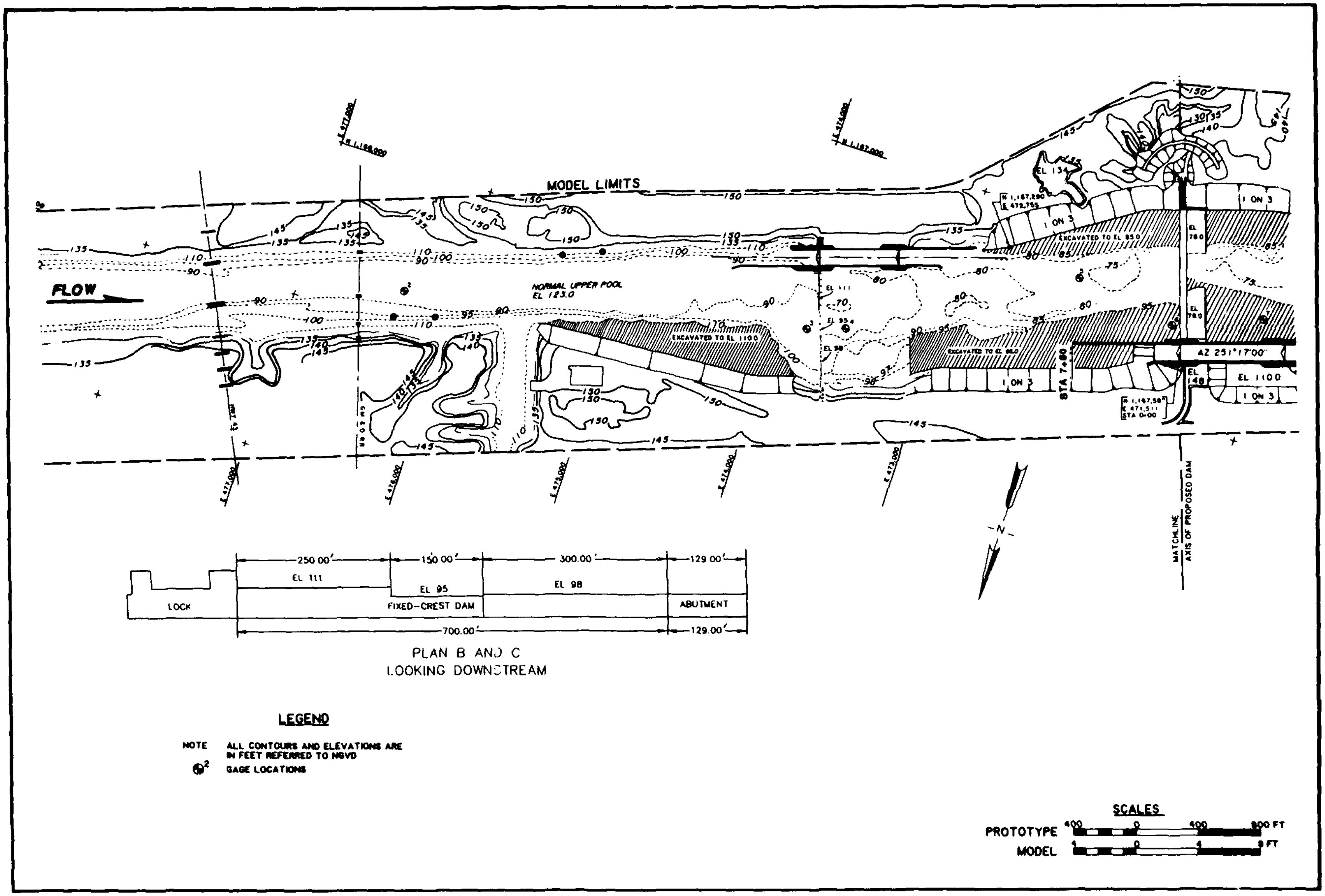


Figure 7. Plan B

b. The 250 ft of existing dam adjacent to the existing lock was removed to el 111.0, the center portion of the dam was removed to el 95.0, and 300 ft of existing dam adjacent to the right bank and the abutment were removed to el 98.0.

c. The right bank and channel bottom upstream of the new lock and the right end of the dam were excavated to el 95.0.

Results

34. Water-surface elevations. Water-surface elevations shown in Table 4 indicate no significant change in water-surface elevations compared with Plan A.

35. Current directions and velocities. Data obtained with the gates of the existing lock open are shown in Plate 17. A clockwise eddy formed along the right bank in the excavation upstream of the existing dam with the 60,000- and 100,000-cfs riverflows, indicating the increased excavation would not improve the current alignment in the vicinity. With the gates of the existing lock closed, current direction and velocity data indicate the flow into the excavation would increase (Plate 18).

36. Navigation conditions. Navigation conditions for tows entering and leaving the new lock were generally the same as with Plan A. Downbound tows driving through the navigation span of the bridges could experience some difficulties entering the upstream end of the excavated channel due to the sharp turn required. With riverflows above 60,000 cfs, downbound tows would be required to make a flanking maneuver to move into the excavated channel; therefore, no significant benefits were gained from the increased excavation of the right bank.

Plan C

Description

37. Plan C (Figure 8) was the same as Plan A except for the following:

a. The upper guard wall was shortened 88 ft from sta 7+80 to sta 6+92 due to design considerations, providing a 526-ft ported wall with sixteen 20-ft-wide ports and fifteen 10-ft-wide piers with the top of the ports at el 121.0.

b. The 250 ft of existing dam adjacent to the existing lock was removed to el 111.0, the center portion of the dam was removed to el 95.0, and 300 ft of existing dam adjacent to the right bank and the abutment was removed to el 98.0.

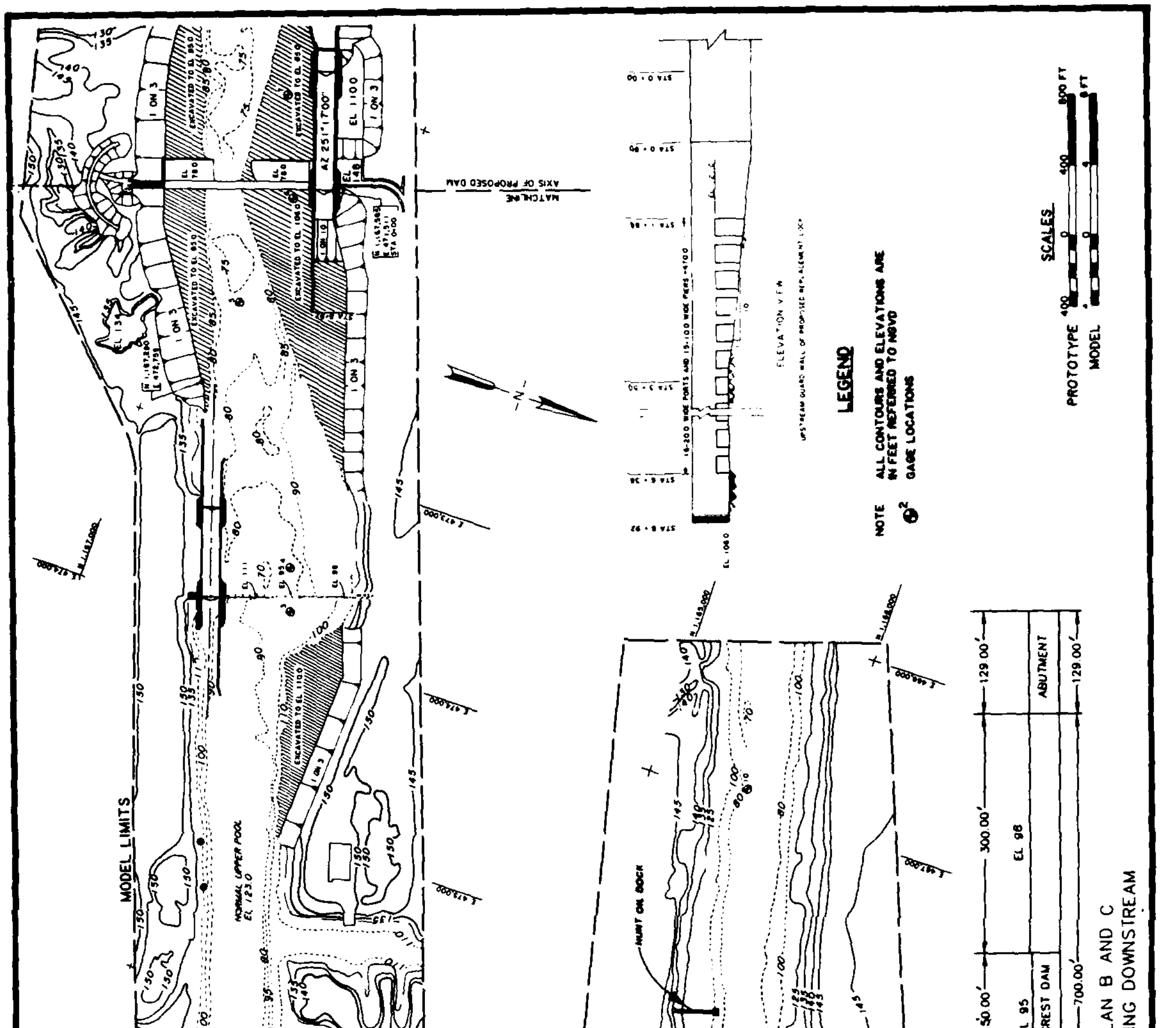


Figure 8. Plan C

Results

38. Water-surface elevations. Water-surface elevations obtained with Plan C conditions and the tailwater controlled to elevations established during the base test (Table 5) indicate no significant change compared to Plan A.

39. Current directions and velocities. Data obtained with the gates of the existing lock closed (Plate 19) and with the gates open (Plate 20) indicate no significant change in the alignment or velocities of the currents compared with Plan A. The maximum velocity of the currents in the navigation channel about 1,000 ft upstream of the guard wall varied from about 2.2 to 5.3 fps with riverflows of 30,000 to 100,000 cfs when the gates of the existing lock were closed and from 1.7 to 4.8 fps when the lock gates were opened to pass flow.

40. Navigation conditions. Model tests did not indicate any significant change in navigation conditions for tows entering or leaving the upper lock approach with riverflows through 60,000 cfs. As the riverflow increased to 100,000 cfs, there was a tendency for a downbound tow landing on the upstream end of the shortened upper guard wall, with several hundred feet of the tow exposed to the currents, to be rotated around the upper end of the guard wall. However, downbound tows approaching the lock from along the right bank could land on the guard wall fully protected by the wall and enter the lock chamber without any major difficulties. The longer guard wall tested in Plan A would tend to improve conditions slightly for tows landing on the wall with the 100,000-cfs flow, but would not eliminate the flanking maneuver required to approach with the high-flow conditions.

Plan C-Modified

Description

41. Plan C-Modified (Figure 9) was the same as Plan C except the 300-ft section of the existing dam adjacent to the right bank and the right bank abutment were raised from el 98.0 to el 106.0.

Results

42. Water-surface elevations. Water-surface elevations shown in Table 6 indicate raising a portion of the existing dam would not significantly affect water-surface elevations compared to Plan A.

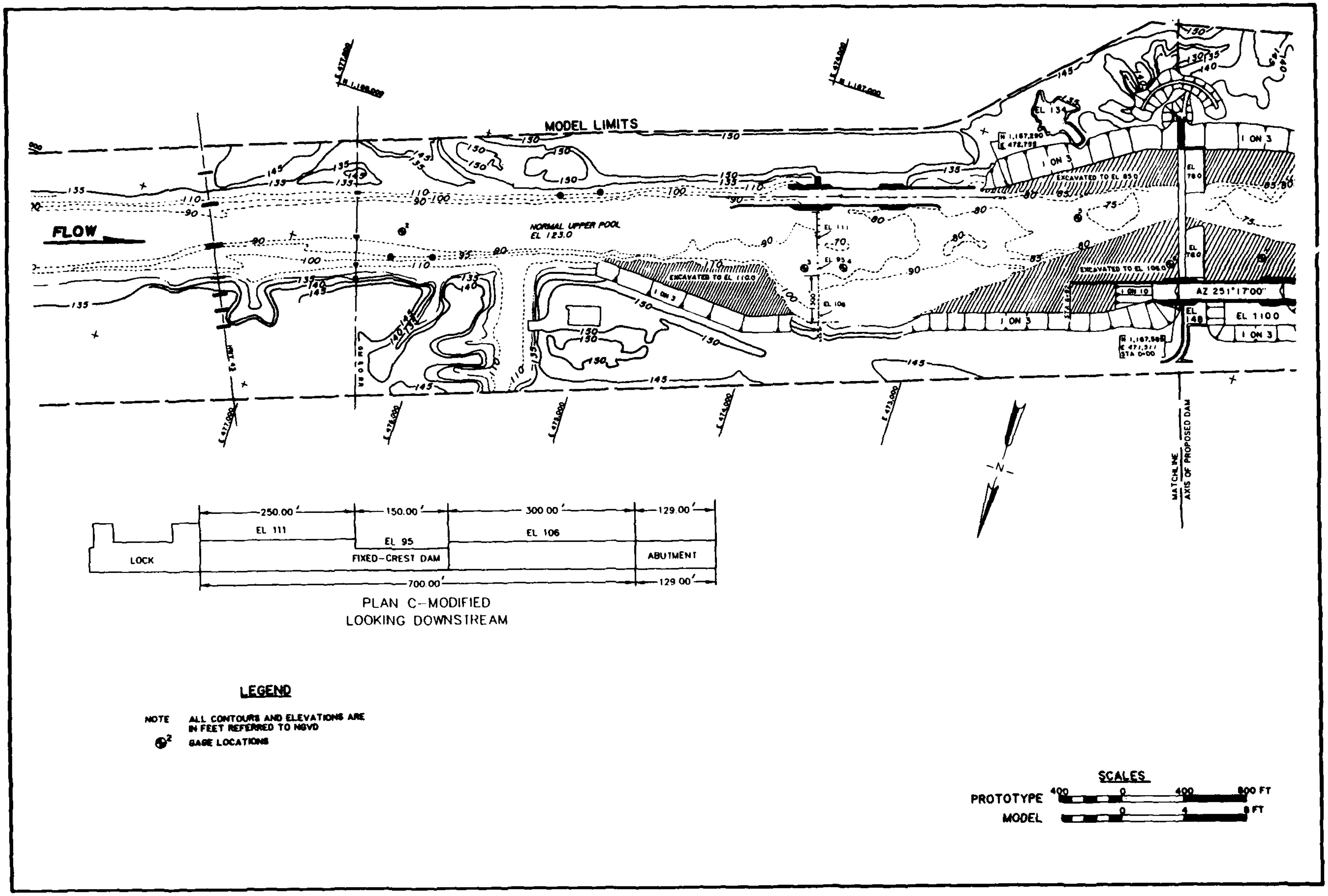


Figure 9. Plan C-Modified

43. Current directions and velocities. Data taken with riverflows controlled to the average tailwater rating curve (Plates 21-25) indicate no significant change in the alignments or velocities of the currents compared with Plan A. The maximum velocity in the navigation channel upstream of the lock varied from about 4.4 to 5.7 fps through the bridges, 3.8 to 5.9 fps near the upstream end of the right bank excavation, and 3.1 to 4.3 fps about 1,000 ft upstream of the guard wall with the 60,000- and 100,000-cfs riverflows, respectively. With riverflows above 100,000 cfs, the maximum velocities in the navigation channel upstream of the dam varied from 6.8 to 7.8 fps through the bridges, 7.0 to 8.3 fps near the upstream end of the right bank excavation, and 4.8 to 6.0 fps immediately upstream of the dam with the 130,000- and 198,000-cfs riverflows, respectively. The maximum velocity in the lower lock approach near the downstream end of the guide wall varied from 2.6 to 3.7 fps with the 60,000- and 100,000-cfs riverflows, respectively. The maximum velocity immediately downstream of the dam varied from 6.1 to 8.5 with the 130,000- and 198,000-cfs riverflows, respectively, and the maximum velocity near the downstream end of the right bank excavation varied from about 3.8 to 7.3 fps with the 60,000- and 198,000-cfs riverflows, respectively.

44. Navigation conditions. Model tests indicated no significant change in navigation conditions for tows entering or leaving the upper lock approach with riverflows through 60,000 cfs compared with Plan C.

Special Tests with Plan C-Modified

Test procedure

45. During previous tests, data were collected with the model controlled to an average tailwater rating curve supplied by the Mobile District. Rising and falling river stages in the prototype produce a significant difference in the tailwater elevation for any given riverflow, thereby changing the drop across the structure. With the model reproducing Plan C-Modified conditions, data were obtained with a range of flows and with the tailwater controlled to both a rising and falling stage tailwater curve. The following flows and tailwater elevations were reproduced in the model:

Riverflow cfs	Tailwater El Rising Stage	Tailwater El Falling Stage
30,000	113.8	123.7
60,000	120.6	132.7
100,000	129.9	139.7
130,000	134.6	143.3
160,000	138.0	145.8
198,000	141.2	147.5

Results

46. Water-surface elevations. Water-surface elevations obtained with the various flows and tailwaters (shown in Table 7) indicate a significant change in water-surface elevations, water-surface slope per mile, and drop across the structure with most of the riverflows. Controlling the model to the rising stage tailwater elevations lowered water-surface elevations, increased the slope through the model reach, and increased the drop across the fixed-crest dam with riverflows of 60,000 cfs and above. The slope in water-surface elevations ranged from about 0.1 to 1.2 ft per mile upstream of the dam and 0.1 to 1.0 ft per mile downstream of the dam. The drop across the dam ranged from about 14.5 to 3.1 ft with riverflows of 30,000 to 198,000 cfs. Controlling the model to the falling stage tailwater elevations raised water-surface elevations, decreased the slope per mile through the reach, and decreased the drop across the fixed-crest dam with riverflows of 30,000 cfs and above. The slope in water-surface elevations ranged from about 0.1 to 0.9 ft per mile upstream of the dam and from less than 0.1 to about 0.7 ft per mile downstream of the dam. The drop across the dam ranged from about 5.4 ft to 1.1 ft with riverflows of 30,000 and 100,000 cfs, respectively.

47. Current directions and velocities. Data obtained with the model controlled to rising stage tailwater elevations (Plates 26-30) indicate the current patterns were generally the same as with the average tailwater curve; however, there was a slight increase in current velocities with riverflows above 60,000 cfs. The maximum velocity in the navigation channel upstream of the lock varied from about 6.5 to 9.1 fps through the bridges, 6.8 to 9.8 fps near the upstream end of the right bank excavation, and 3.8 to 6.7 fps immediately upstream of the dam with the 100,000- and 198,000-cfs riverflows, respectively. The maximum velocities downstream of the dam varied from

3.3 to 7.5 fps in the lower lock approach near the downstream end of the guide wall and from 4.5 to 8.7 fps near the downstream end of the right bank excavation with the 60,000- and 198,000 cfs riverflows, respectively.

48. Navigation conditions. Model tests indicate that tows will not be able to navigate over the dam during rising stages due to the drop across the dam, which ranged from 3.8 to 3.1 ft with the 100,000- and 198,000-cfs flows, respectively. However, navigation conditions were generally the same as average tailwater conditions for tows entering and leaving the lock approaches with riverflows through 130,000 cfs. As the riverflow increased to 130,000 cfs and above, the outdraft near the upstream end of the upper guard wall increased, requiring increased maneuvering for downbound tows to enter the lock approach. With the model controlled to falling stage tailwater elevations, navigation conditions for tows entering and leaving the lock were generally the same as with average stage tailwater elevations. With riverflows of 100,000 cfs and above, the alignment of the currents was satisfactory for upbound and downbound tows to approach the dam; however, the drop across the dam ranged from 1.1 to 1.3 ft, which could create some difficulties and require considerable power for tows to navigate the dam.

PART IV: TESTS AND RESULTS FOR CONSTRUCTION SEQUENCE

First-Stage Cofferdam

Purpose

49. The replacement lock and dam will be constructed in two stages. The lock and 350 ft of the fixed-crest dam will be constructed in a first-stage cofferdam located along the right descending bank, and the remaining portion of the dam will be constructed in a second-stage cofferdam along the left bank. With the first-stage cofferdam in place, the existing lock and dam will be in operation and tows will be required to navigate through the existing structures and past the cofferdam. A navigation channel will be provided along the left bank past the cofferdam. To construct the remainder of the dam, a second-stage cofferdam will be placed along the left bank. With the second-stage cofferdam in place, the pool will be established at the replacement lock and dam and some portion of the existing dam will be removed to provide a navigation pass through the existing structures. During this stage of construction the replacement lock will be in operation and tows will use the lock to move through the reach.

50. Tests were conducted to investigate the effects on navigation during the construction stages of the project and develop modifications or restrictions necessary for safe navigation through the reach. Tests were also conducted to determine the effects of the first-stage cofferdam and second-stage cofferdam on water-surface slopes through the reach.

Description

51. The principal features of the first-stage cofferdam (Figure 10 and Photo 18) were the same as existing conditions except for the following:

- a. A cofferdam with top el 150.0 was placed along the right bank about 2,600 ft downstream of the existing dam for construction of the replacement lock and 350 ft of the replacement dam.
- b. The left bank and channel bottom were excavated to el 85.0 beginning near the downstream end of the existing guide wall and extending downstream about 2,400 ft to provide a navigation channel with a 400-ft minimum width past the cofferdam. Additional excavation indicated by preliminary tests was incorporated into the model.
- c. The mooring cells along the left bank downstream of the existing lock were removed.

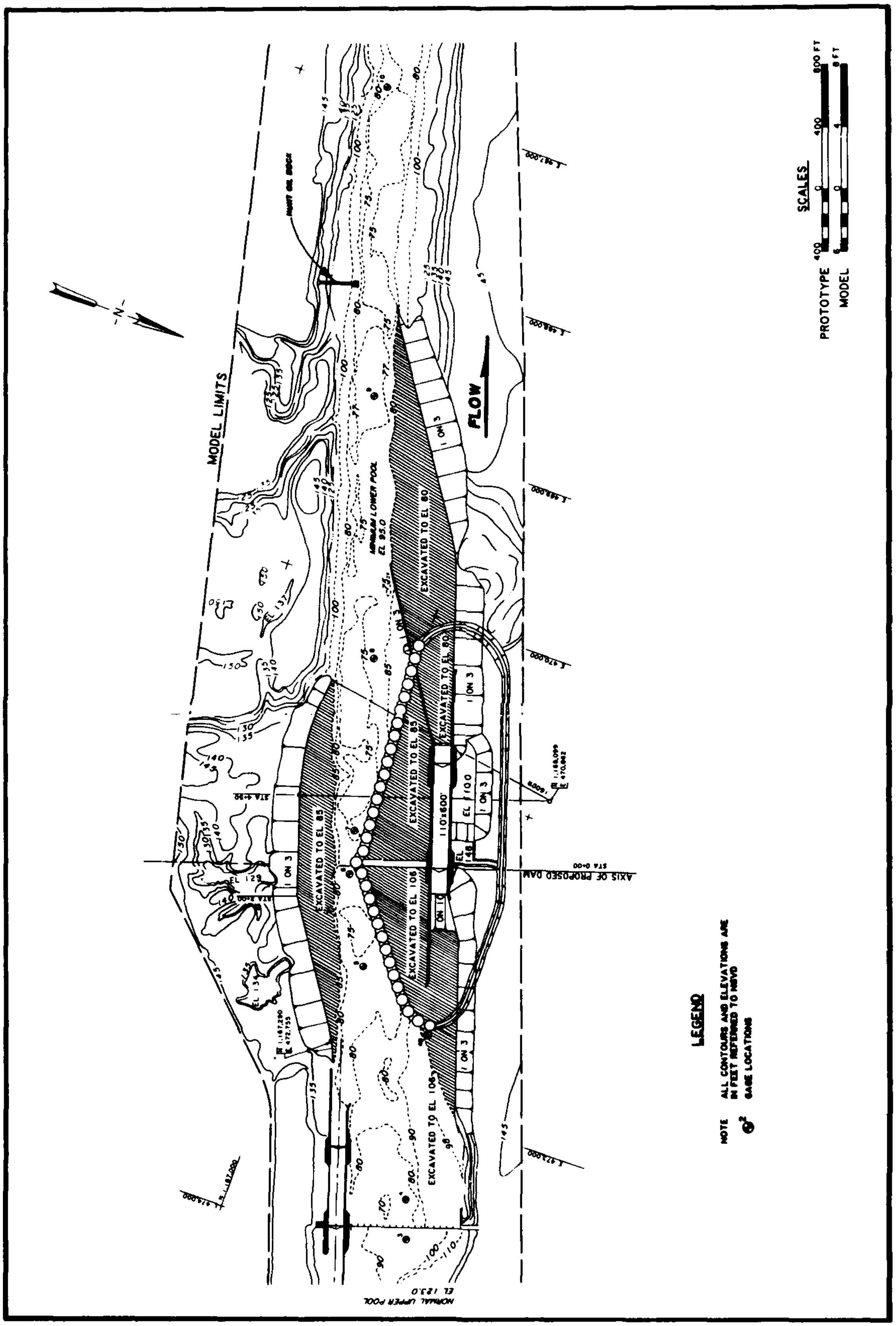


Figure 10. First-stage cofferdam

d. The right bank upstream and downstream of the cofferdam was excavated to el 106.0 and 80.0, respectively, to provide navigation channels to the new lock.

Results

52. Water-surface elevations. Water-surface elevations shown in Table 8 indicate a slight increase in water-surface elevations upstream of the cofferdam and no significant change downstream of the cofferdam compared with the base test. The increase in water-surface elevations varied from 0.2 to 0.3 ft at Gage 6, 0.1 to 0.5 ft at Gage 4B, and 0.1 to 0.2 ft at Gage 3 with riverflows of 30,000 and 198,000 cfs, respectively. There was no significant change in the drop across the existing dam with the drop ranging from 14.8 ft to 2.2 ft with riverflows ranging from 30,000 to 198,000 cfs.

53. Current directions and velocities. Data shown in Plates 31-33 and surface current patterns shown in Photos 19-21 indicate the currents were generally parallel with the upstream portion of the cofferdam and followed the bank alignment on the downstream end of the excavation. Currents with this plan were concentrated on the left side of the river in the vicinity of the cofferdam. Maximum velocities in the vicinity ranged from 4.3 fps with a flow of 30,000 cfs to 6.4 fps with a flow of 100,000 cfs. Velocities along the left bank in the vicinity of the cofferdam were considerably higher than those with existing conditions.

54. Navigation conditions. Conditions were satisfactory for upbound tows moving past the cofferdam and entering the existing lock with all flows tested (Photos 22-24). However, due to the alignment and velocity of the currents in the vicinity of the cofferdam, considerable maneuvering and power could be required for tows to move past the cofferdam with riverflows of 30,000 cfs and above. A downbound tow leaving the existing lock would tend to be pushed toward the left bank as it approached the midpoint of the cofferdam; however, the channel width appeared to be sufficient to allow the tows to move through the area without any major difficulties or hazards (Photos 25-27).

Second-Stage Cofferdam, Plan A

Description

55. The principal features of the second-stage cofferdam, Plan A (Figure 11), were as follows:

a. The 110- by 600-ft replacement lock with its upper guard wall

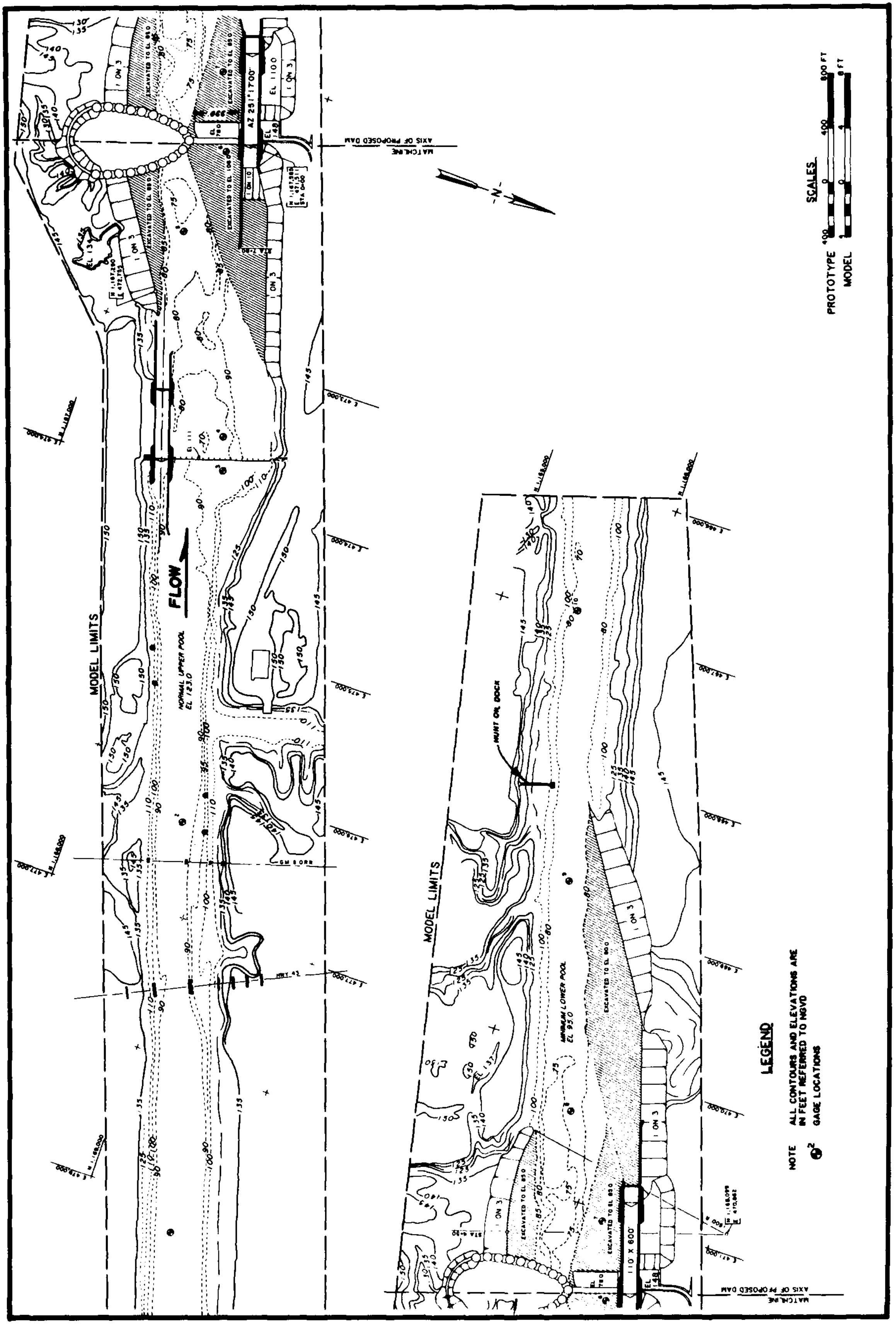


Figure 11. Second-stage cofferdam, Plan A

and lower guide wall was in place adjacent to the right bank downstream of the existing structures.

b. The right bank upstream and downstream of the replacement lock was excavated to el 106.0 and 80.0, respectively, to provide navigation channels to the new lock.

c. The left bank and channel bottom were excavated to el 85.0 beginning near the downstream end of the existing guide wall and extending downstream about 2,400 ft.

d. The 350-ft section of the new dam adjacent to the replacement lock was in place.

e. The second-stage cofferdam with top el 155.0 was in place adjacent to the left bank and extended from the left bank and incorporated the left end of the partially completed dam. This configuration provided 330 ft of the new dam for passing flow.

f. The existing dam from the existing lock to the right bank abutment was removed to el 111.0.

Results

56. Water-surface elevations. Water-surface elevations shown in Table 9 indicate a significant increase in water-surface elevations upstream of the replacement structure due to the short length of dam passing flow (330 ft) compared to the base test. The increase in water-surface elevations extended upstream from the replacement structure to the upstream limits of the model with all flows tested. The largest increase occurred between the replacement structure and the existing dam. The increase in water-surface elevations ranged from 3.3 to 6.7 ft at Gage 1, near the upstream limits of the model; 3.4 to 6.8 ft at Gage 3, located immediately upstream of the existing dam; and 18.2 to 9.4 ft at Gage 4, immediately downstream of the dam, with the 30,000- and 100,000-cfs flows, respectively. As the riverflow increased to 130,000 cfs and above, the effects of the cofferdam and replacement structure on water-surface elevations decreased due to the increased flow-carrying capacity as the structures overtopped. With the 198,000-cfs riverflow, water-surface elevation increased 3.8 ft at Gage 1, 4.0 ft at Gage 3, and 5.9 ft at Gage 4 compared with the base test. The drop across the replacement structure ranged from about 18.1 to 5.6 ft with the 30,000- and 198,000-cfs riverflows, respectively.

57. Current directions and velocities. Data shown in Plates 34-36 indicate the currents were generally parallel to the bank lines from upstream of the bridges to about 3,600 ft upstream of the axis of the replacement dam, then moved toward the right bank and into the approach of the replacement

lock. The currents approaching the replacement lock turned toward the dam about 1,000 ft upstream of the guard wall and moved across the lock approach. The maximum velocity in the navigation channel upstream of the replacement lock varied from about 2.3 to 4.6 fps through the bridges, 2.1 to 5.3 fps about 3,600 ft upstream of the replacement lock, and 1.5 to 3.9 fps about 1,000 ft upstream of the guard wall with the 30,000- and 100,000-cfs riverflows, respectively. With riverflows of 60,000 cfs and below, the flow was concentrated over the 330-ft useable portion of the dam adjacent to the replacement lock, creating high-velocity currents along the riverside lock wall that turned toward the left bank near the downstream end of the lock wall. A large counterclockwise eddy formed downstream of the cofferdam with a maximum upstream current velocity of 3.6 fps occurring with the 60,000-cfs riverflow. A large clockwise eddy formed in the lower approach to the replacement lock with the maximum upstream current velocity of 5.6 fps occurring with the 60,000-cfs riverflow. As the riverflow increased to 100,000 cfs, the eddy downstream of the cofferdam increased in size and intensity and high-velocity currents moved across the lower lock approach.

58. Navigation conditions. Conditions were satisfactory for upbound tows leaving the replacement lock with all riverflows tested, and for downbound tows with riverflows through 30,000 cfs. With a riverflow of 30,000 cfs, a downbound tow could navigate through the center of the navigation spans of the bridges, turn toward the right bank in the vicinity of the existing lock, align with the guard wall one to two tow lengths upstream of the lock, and approach the lock at a slow rate of speed. As the riverflow increased to 60,000 cfs, a downbound tow would experience some difficulties turning toward the right bank and aligning with the replacement lock due to the increased velocity of the currents, the reverse turn required to enter the lock approach, and the limited length of straight approach.

59. Navigation conditions were poor to hazardous for tows entering and leaving the lower lock approach with all flows tested. The large eddy in the lower lock approach and the erratic currents downstream of the approach made approaching the lock very difficult. An upbound tow tended to be rotated clockwise, moved out of the lock approach and toward the left bank, or grounded on the right bank by the concentrated flow moving from along the lock wall. In some instances the tow could lose control in the vicinity of the lock and be rotated a full 180 deg. A downbound tow tended to be rotated in

the eddy and pushed into the left bank near the downstream end of the lower approach.

Second-Stage Cofferdam, Plan B

Description

60. Plan B (Figure 12) was developed to improve navigation conditions for downbound tows approaching the new lock and was the same as second-stage cofferdam Plan A except for the following:

   a. The channel bottom upstream of the existing dam was excavated to el 90.0, and the right bank in the same vicinity was excavated landward the maximum allowable amount that would not encroach on the existing access road.

   b. Three submerged dikes of various lengths with top el 108.0 were added in the main river channel at river miles 338.47, 338.37, and 338.28. The dikes were connected to the left bank, spaced about 500 ft apart, and angled upstream to provide the most efficient movement of currents from the main river channel into the right bank excavation.

Results

61. Water-surface elevations. Water-surface elevations shown in Table 9 indicate slight changes in water-surface elevations in the immediate vicinity of the submerged dikes but no significant change through the pool compared to the second-stage cofferdam Plan A.

62. Current directions and velocities. Data shown in Plates 37 and 38 indicate the submerged dikes and right bank excavation increased the flow along the right bank from upstream of the existing dam to the lock forebay with the 30,000- and 60,000-cfs riverflows compared with Plan A. There was also a corresponding increase in the velocity of the currents along the right bank and in the upper lock approach with a maximum velocity of 4.2 fps occurring with the 60,000-cfs riverflow in the vicinity of the submerged dikes.

63. Navigation conditions. Conditions were satisfactory for tows entering and leaving the upper lock approach with riverflows through 60,000 cfs. A downbound tow navigating through the center of the navigation spans of the bridges could turn from the main river channel into the excavation along the right bank, align with the guard wall approximately two tow lengths upstream of the guard wall, and enter the lock forebay at a slow speed.

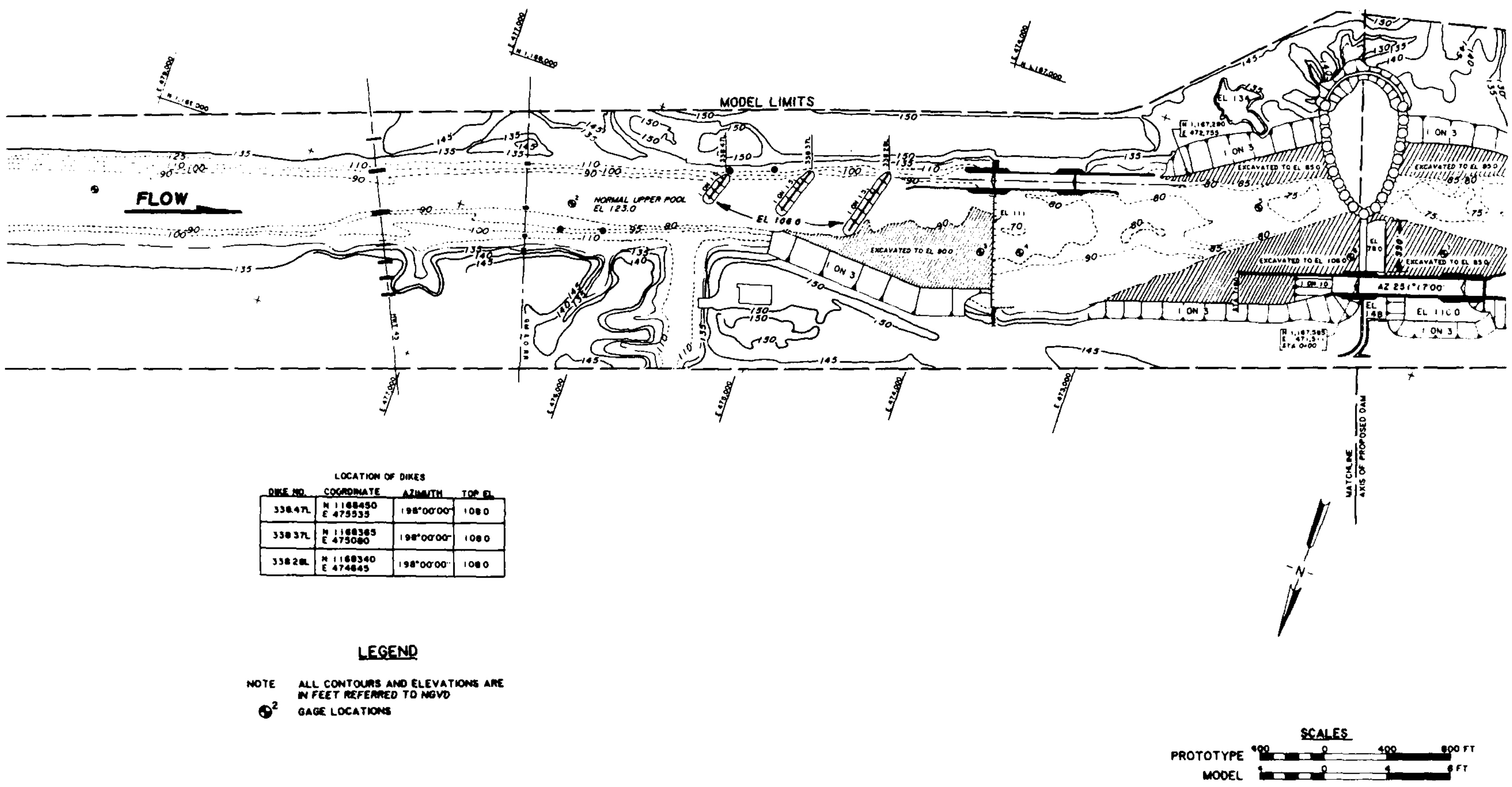


Figure 12. Second-stage cofferdam, Plan B

Second-Stage Cofferdam, Plan C

Description

64. Plan C (Figure 13) was developed to eliminate the hazardous navigation conditions created in the lower lock approach with the second-stage cofferdam in place and was the same as second-stage cofferdam Plan A except

- a. The channel bottom upstream of the existing dam was excavated to el 110.0, and the right bank in the same vicinity was excavated landward the maximum allowable amount that would not encroach on the existing access road.
- b. The existing dam and right bank abutment were removed to el 98.0 except 250 ft of the dam adjacent to the lock, which was removed to el 111.0 (12 ft below minimum pool).
- c. The lower lock approach was modified by retaining a portion of the river leg of the first-stage cofferdam, excavating a canal with 120-ft bottom width into the lock, and adding a spur dike off the downstream end of the island formed by the excavation. The upper end of the canal was closed to flow by additional cells placed from the upstream end of the remaining first-stage cofferdam to the river wall of the lock.

Results

65. Water-surface elevations. Water-surface elevations shown in Table 9 indicate no significant change in water-surface elevations compared to second-stage cofferdam Plan A.

66. Current directions and velocities. Data shown in Plates 39-41 and surface current patterns shown in Photo 28 indicate the alignment of the currents upstream of the dam was generally the same as with Plan A of the completed project test series, except in the immediate vicinity of the dam, where the flow was concentrated over the completed portion of the dam adjacent to the lock. The velocity of the currents was generally less than with Plan A due to the increase in water-surface elevations, which can be attributed to the second-stage cofferdam. The maximum velocity in the navigation channel upstream of the lock varied from about 2.4 to 5.0 fps through the bridges, 2.5 to 5.1 fps near the upstream end of the right bank excavation, and 2.0 to 4.1 fps about 1,000 ft upstream of the guard wall with the 30,000- and 100,000-cfs riverflows, respectively. Downstream of the dam the currents were moved toward the left bank by the training structure, and the currents remained generally parallel to the left bank through the model reach (Photo 29). A clockwise eddy formed in the lower lock approach downstream of the training

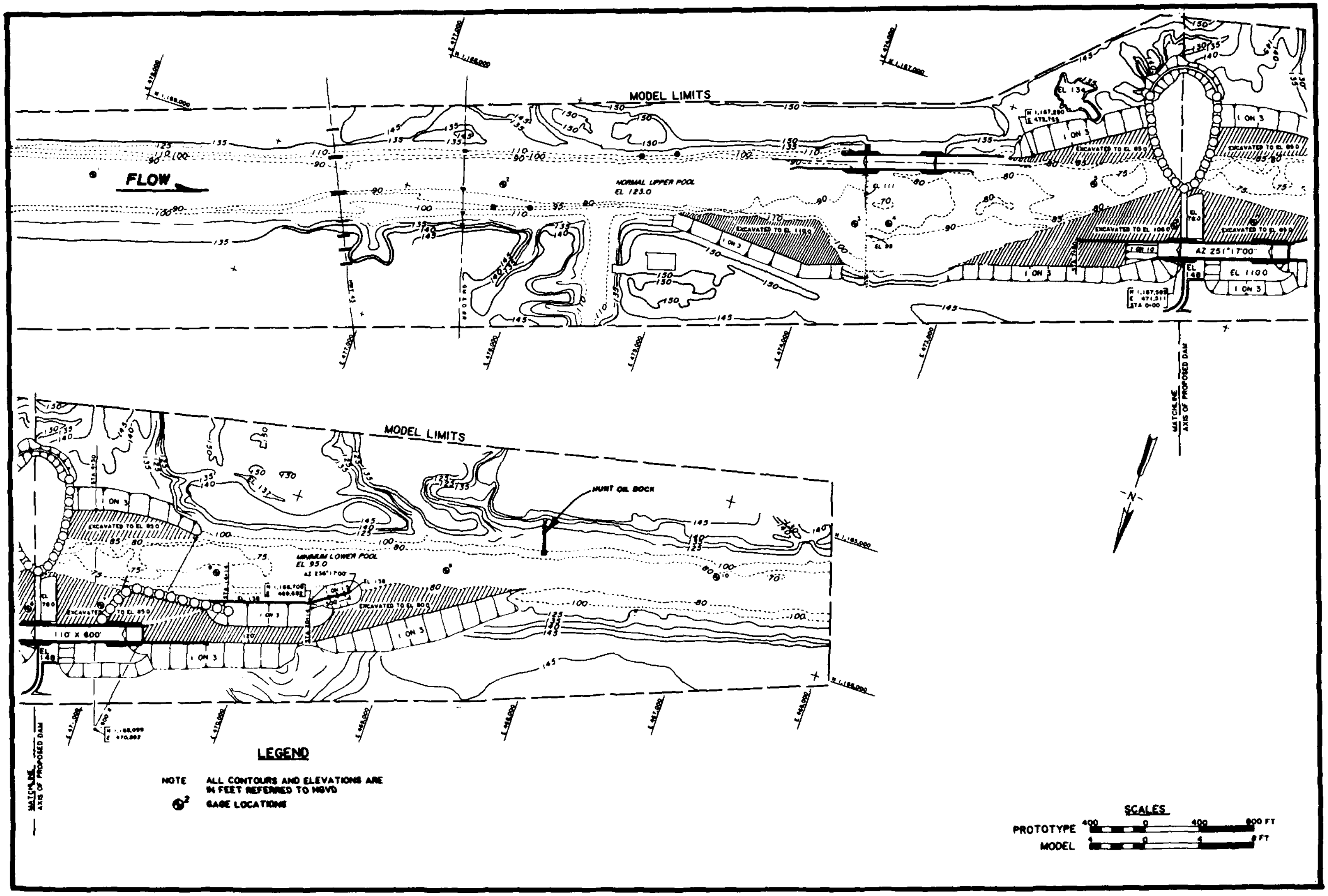


Figure 13. Second-stage cofferdam, Plan C

structure. The maximum velocity of the currents in the vicinity of the downstream end of the right bank excavation ranged from about 4.7 to 6.1 fps with the 30,000- and 100,000-cfs riverflows, respectively.

67. Navigation conditions. Conditions upstream of the dam were generally the same as with Plan A of the previous series. With riverflows through 60,000 cfs, downbound tows could navigate through the center of the bridges, move into the right bank excavation, align with the lock one to two tow lengths upstream of the guard wall, and approach the guard wall at a slow rate of speed (Photo 30). As the riverflow increased above 60,000 cfs, a downbound tow could begin a flanking maneuver as it cleared the bridges, move into the right bank excavation, approach the lock from along the right bank, and enter the lock forebay at a slow speed. There was no indication of any major difficulties for upbound tows leaving the lock (Photo 31). Navigation conditions for tows entering and leaving the lower lock canal were satisfactory with all riverflows tested up though 60,000 cfs. There was a slight eddy at the downstream end of the lock canal that had some effect on the tow but was not severe enough to be hazardous to navigation. At the minimum pool of el 95.0 the canal width was minimal, but it appeared that a tow could make the turn to the lock without danger of being grounded on the canal banks. There was no indication of major difficulties for tows leaving the lower lock canal (Photo 32).

Second-Stage Cofferdam, Plan D

Description

68. Plan D was the same as Plan C except the second-stage cofferdam was changed to a rectangular configuration with a straight riverward face that was parallel to the lock. The first-stage cofferdam cells forming the upstream end of the training structure in the vicinity of the lower lock approach were replaced with a row of cells extending from the riverward lock wall to the existing embankment (Figure 14 and Photo 33). The fixed-crest dam available to pass flow remained the same as with Plan C (330 ft).

Results

69. Water-surface elevations. Elevations shown in Table 9 indicate an increase of 0.3 to 0.4 ft upstream of the cofferdam with riverflows of 30,000 and 60,000 cfs compared with second-stage cofferdam Plan C. As the riverflow

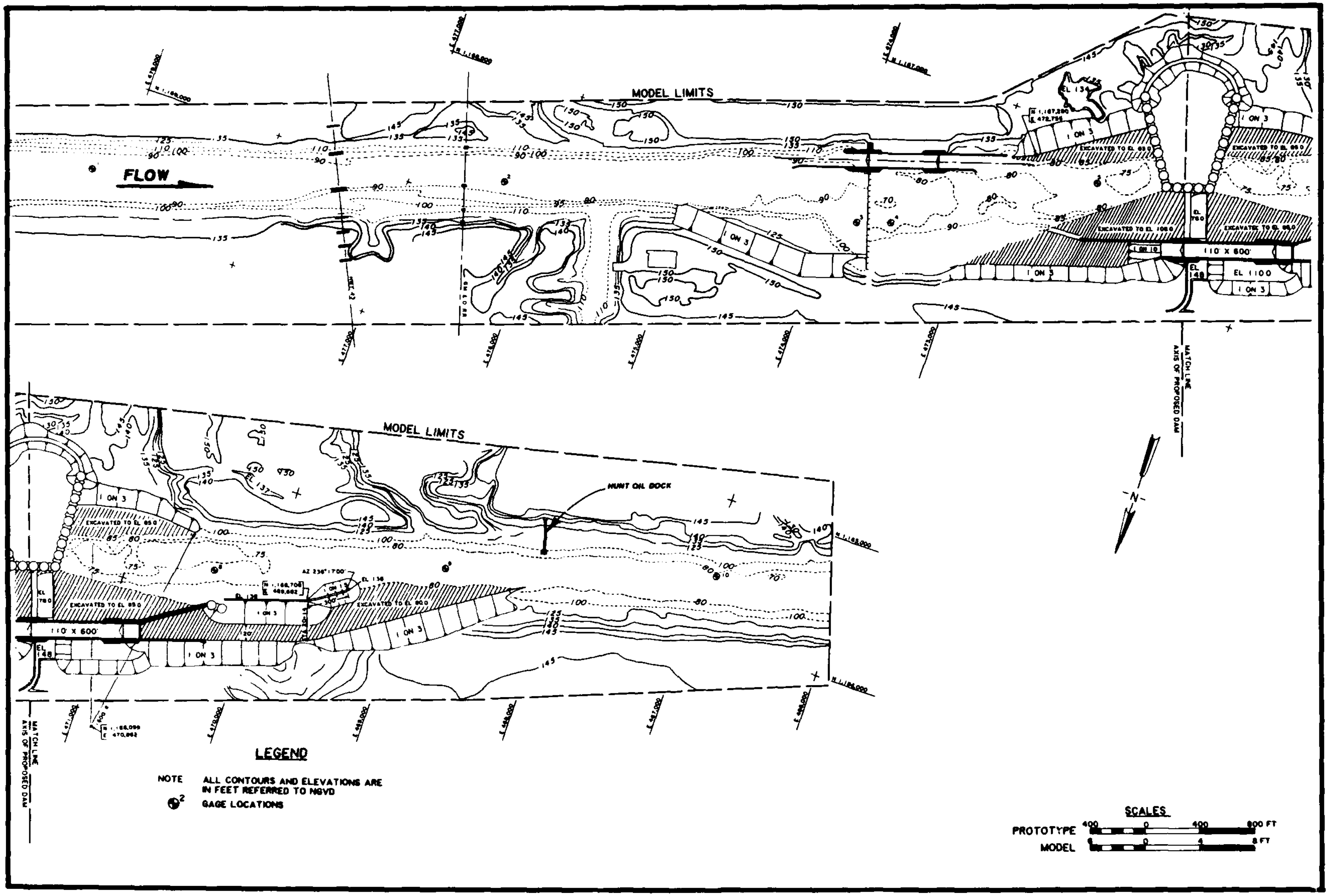


Figure 14. Second-stage cofferdam, Plan D

increased above 100,000 cfs, flow began to pass over the lock and access road, and there was no indication of any significant change in water-surface elevations compared to Plan C.

70. Current directions and velocities. Data shown in Plates 42-44 and Photos 34 and 35 indicate the alignment and velocity of the currents were generally the same as with second-stage cofferdam Plan C except in the immediate vicinity of the cofferdam. The straight riverward face of the cofferdam and the straight closure between the lock and the canal embankment provided more uniform flow through the reach compared to Plan C. The maximum velocity of the currents near the downstream end of the right bank excavation varied from about 3.3 to 4.8 fps with the 30,000- and 100,000-cfs riverflows.

71. Navigation conditions. Conditions were generally the same through the model reach as with second-stage cofferdam Plan C. With riverflows through 60,000 cfs, downbound tows could drive along the right bank and enter the lock without any major difficulties (Photo 36). As the riverflow increased above 60,000 cfs, a downbound tow could begin a flanking maneuver as it cleared the bridges, move into the right bank excavation, approach the lock from along the right bank, and enter the lock forebay at a slow speed (Photo 37). There was no indication of any major difficulties for upbound tows leaving the lock (Photo 38). Navigation conditions for tows entering and leaving the lower lock canal were satisfactory with all riverflows tested up to 100,000 cfs. At a minimum pool el of 95.0, the canal width was minimal, but a tow could make the turn to the lock without being pushed into the bank of the canal. Tows could enter and leave the lower lock approach and river channel without any major difficulties (Photos 39 and 40).

PART V: DISCUSSION OF RESULTS AND CONCLUSIONS

Limitations of Model Results

72. Analysis of the results of this investigation is based on a study of the effects of various plans and modifications on water-surface elevations and current directions and velocities, and the effects of the resulting currents on the behavior of the model towboat and tow. In evaluating test results, it should be considered that small changes in current directions and velocities are not necessarily changes produced by a modification in the plan since several floats introduced at the same point may follow a different path and move at somewhat different velocities because of pulsating currents and eddies. Current directions and velocities shown in the plates were obtained with floats submerged to a depth of a loaded barge (8 ft prototype) and are more indicative of the currents that would affect the behavior of tows than those indicated by photographs, which indicate the movement of confetti on the water surface and could be affected by surface tension.

73. The small scale of the model made it difficult to reproduce accurately the hydraulic characteristics of the prototype structures or to measure water-surface elevation within an accuracy greater than about ±0.1 ft prototype. Also, current directions and velocities were based on steady flows and would be somewhat different with varying flows. The model was of the fixed-bed type and was not designed to reproduce overall sediment movement that might occur in the prototype with the various plans; therefore, changes in channel configuration resulting from scouring and deposition and any resulting changes in current directions and velocities were not evaluated.

Summary of Results and Conclusions

72. The following results and conclusions were developed during the investigation:

- a. Plan A provides satisfactory navigation conditions for upbound tows leaving the replacement lock and for tows entering and leaving the lower lock approach with riverflows through 60,000 cfs.
- b. Locating the replacement lock immediately downstream of the existing structures and along the right bank will require

downbound tows to move through the navigation spans of the highway and railroad bridges adjacent to the left bank, turn toward the right bank as quickly as possible, enter the right bank excavation, and turn toward the left to align with the replacement lock, all in a very limited distance. As the velocity of the currents increases, this maneuver becomes more difficult.

c. With the alignment and location of the replacement lock and dam, upper and lower lock approaches, demolition scheme for the existing dam, and right bank excavation in Plan A, downbound tows could approach the replacement lock without any major difficulties through the 60,000-cfs riverflow.

d. With Plan A and riverflows greater than 60,000 cfs, downbound tows could experience some difficulties driving into the replacement lock; however, the tow could begin a flanking maneuver immediately downstream of the railroad bridge, move to the right bank, and approach the lock along the right bank without any major difficulties.

e. Placing submerged dikes in the river channel downstream of the bridges as in Plan A-Modified would increase the flow along the right bank but could adversely affect navigation due to the increase in outdraft near the upstream end of the guard wall.

f. Additional excavation along the right bank as in Plan B would not improve navigation conditions into the replacement lock because the tow could not use the additional area.

g. With the 526-ft-long ported upper guard wall in Plans C and C-Modified, upper and lower lock approaches, demolition scheme for the existing dam, and right bank excavation, downbound tows could approach the replacement lock without any major difficulties through the 60,000-cfs riverflow.

h. With Plan C-Modified and riverflows greater than 60,000 cfs, downbound tows could experience some difficulties driving into the replacement lock; however, the tow could begin a flanking maneuver immediately downstream of the railroad bridge, move to the right bank, and approach the lock along the right bank without any major difficulties.

i. With Plans C and C-Modified, as the riverflow increased to 100,000 cfs there was a tendency for a downbound tow landing on the upper guard wall near the upstream end, with several hundred feet of the tow exposed to the currents, to be rotated around the upper end of the guard wall. However, downbound tows approaching the lock from along the right bank could land on the guard wall fully protected by the wall and enter the lock chamber without any major difficulties.

j. With Plan C-Modified, the minimum drop of 1.1 ft across the dam occurred with the model controlled to the falling tailwater curve and a riverflow of 100,000 cfs. The alignment of the currents was satisfactory for upbound and downbound tows to approach the dam; however, the drop across the dam could create

some difficulties and require considerable power for tows to navigate the dam.

k. With first-stage cofferdam Plan A, considerable power and maneuvering could be required for upbound tows to move past the cofferdam with riverflows of 30,000 cfs and above.

l. The second-stage cofferdam will increase the water-surface elevations upstream of the existing dam about 3.0 to 7.0 ft, depending on the riverflow.

m. During the second stage of construction, the concentrated flow over the completed section of the dam will tend to create hazardous conditions for navigation in the lower lock approach.

n. A training structure on the riverside of the lower approach channel similar to the one in second-stage cofferdam Plans C and D would eliminate most of the adverse affects to navigation in the lower lock approach.

o. Second-stage cofferdam Plans C and D provide satisfactory navigation conditions for downbound tows driving into the replacement lock with riverflows through 60,000 cfs. However, as the riverflow increases above 60,000 cfs, a flanking maneuver could be required for tows to approach the lock at a slow speed.

p. The Hunt Oil Dock as located in the model restricts the navigation channel width in an area in which the tows would be maneuvering to enter or leave the lower approach and could become a hazard to navigation under some conditions.

Table 1

Water-Surface Elevations, Base Test

Gage No.	Water-Surface Elevations, ft NGVD, for Discharge, 1,000 cfs					
	30	60	100	130	160	198
1	128.7	131.3	139.0	143.9	147.4	150.6
2	128.7	131.1	138.7	143.4	146.8	150.1
3	128.6	131.1	138.6	143.2	146.6	149.7
4	113.7	125.6	135.9	140.9	144.5	147.5
4A*	114.0	126.0	136.5	141.5	145.0	148.0
5	113.9	125.9	136.5	141.4	145.0	147.8
6	113.8	125.9	136.4	141.3	144.9	147.7
7	113.8	125.8	136.3	141.2	144.8	147.6
8	113.8	125.8	136.3	141.1	144.7	147.4
9	113.8	125.8	136.3	141.2	144.6	147.4
10	113.8	125.8	136.2	141.1	144.5	147.3

* Controlled elevation.

Table 2

Water-Surface Elevations, Plan A

Gage No.	Water-Surface Elevations, ft NGVD, for Discharge, 1,000 cfs					
	30	60	100	130	160	198
			Existing Lock Gates Closed			
1	128.7	131.3	139.0	143.9	147.5	150.5
2	128.7	131.2	138.7	143.4	146.9	150.0
3	128.6	131.1	138.6	143.2	146.7	149.5
4	128.6	131.1	138.6	143.2	146.6	149.5
5	128.6	131.1	138.5	143.2	146.6	149.5
6	128.5	131.0	138.4	143.1	146.5	149.2
7	114.0	126.0	136.5	141.5	145.0	147.9
8	113.9	126.0	136.5	141.5	145.0	147.9
9	113.9	125.9	136.4	141.4	144.8	147.7
10*	113.8	125.8	136.2	141.1	144.5	147.3
			Existing Lock Gates Open			
1	128.7	131.3	139.0	143.9	147.5	150.5
2	128.7	131.2	138.7	143.4	146.9	150.0
3	128.6	131.1	138.6	143.2	146.7	149.5
4	128.6	131.1	138.6	143.2	146.6	149.5
5	128.6	131.1	138.5	143.2	146.6	149.5
6	128.5	131.0	138.4	143.1	146.5	149.2
7	114.0	126.0	136.5	141.5	145.0	147.9
8	113.9	126.0	136.5	141.5	145.0	147.9
9	113.9	125.9	136.4	141.4	144.8	147.7
10*	113.8	125.8	136.2	141.1	144.5	147.3

* Controlled elevation.

Table 3

Water-Surface Elevations, Plan A-Modified

Gage No.	Water-Surface Elevations, ft NGVD, for Discharge, 1,000 cfs 30	60	100	130	160	198
1	128.8	131.4	139.3	144.0	147.6	150.8
2	128.8	131.2	139.0	143.6	147.2	150.2
3	128.7	131.0	138.6	143.2	146.7	149.5
4	128.7	131.0	138.5	143.1	146.7	149.4
5	128.6	130.9	138.5	143.1	146.6	149.3
6	128.6	130.8	138.4	143.0	146.5	149.2
7	113.9	126.0	136.6	141.4	145.0	147.8
8	113.9	126.0	136.6	141.4	144.9	147.7
9	113.9	125.9	136.4	141.3	144.8	147.5
10*	113.8	125.8	136.2	141.1	144.5	147.3

* Controlled elevation.

Table 4

Water-Surface Elevations, Plan B

Gage No.	Water-Surface Elevations, ft NGVD, for Discharge, 1,000 cfs 30	60	100	130	160	198
1	128.7	131.3	139.0	143.9	147.5	150.5
2	128.7	131.2	138.7	143.4	146.9	150.0
3	128.6	131.1	138.6	143.2	146.7	149.5
4	128.6	131.1	138.6	143.2	146.6	149.5
5	128.6	131.1	138.5	143.2	146.6	149.5
6	128.5	131.0	138.4	143.1	146.5	149.2
7	114.0	126.0	136.5	141.5	145.0	147.9
8	113.9	126.0	136.5	141.5	145.0	147.9
9	113.9	125.9	136.4	141.4	144.8	147.7
10*	113.8	125.8	136.2	141.1	144.5	147.3

* Controlled elevations.

Table 5

Water-Surface Elevations, Plan C

Gage No.	Water-Surface Elevations, ft NGVD, for Discharge, 1,000 cfs					
	30	60	100	130	160	198
1	128.7	131.3	139.0	143.9	147.5	150.5
2	128.7	131.2	138.7	143.4	146.9	150.0
3	128.6	131.1	138.6	143.2	146.7	149.5
4	128.6	131.1	138.6	143.2	146.6	149.5
5	128.6	131.1	138.5	143.2	146.6	149.5
6	128.5	131.0	138.4	143.1	146.5	149.2
7	114.0	126.0	136.5	141.5	145.0	147.9
8	113.9	126.0	136.5	141.5	145.0	147.9
9	113.9	125.9	136.4	141.4	144.8	147.7
10*	113.8	125.8	136.2	141.1	144.5	147.3

* Controlled elevation.

Table 6

Water-Surface Elevations, Plan C-Modified

Gage No.	Water-Surface Elevations, ft NGVD, for Discharge, 1,000 cfs					
	30	60	100	130	160	198
1	128.7	131.3	139.0	143.9	147.5	150.5
2	128.7	131.2	138.7	143.4	146.9	150.0
3	128.6	131.1	138.6	143.2	146.7	149.5
4	128.6	131.1	138.6	143.2	146.6	149.5
5	128.6	131.1	138.5	143.2	146.6	149.5
6	128.5	131.0	138.4	143.1	146.5	149.2
7	114.0	126.0	136.5	141.5	145.0	147.9
8	113.9	126.0	136.5	141.5	145.0	147.9
9	113.9	125.9	136.4	141.4	144.8	147.7
10*	113.8	125.8	136.2	141.1	144.5	147.3

* Controlled elevations.

Table 7

Water-Surface Elevations, Plan C-Modified

Gage No.	Water-Surface Elevations, ft NGVD, for Discharge, 1,000 cfs					
	30	60	100	130	160	198
			Rising Stages			
1	128.7	131.5	135.9	139.9	143.3	147.0
2	128.7	131.4	135.5	139.4	142.6	146.0
3	128.6	131.2	135.2	139.1	142.2	145.6
4	128.6	131.2	135.2	139.1	142.2	145.6
5	128.6	131.2	135.2	139.0	142.2	145.4
6	128.5	131.1	135.1	138.8	141.9	145.2
7	114.0	120.8	130.3	135.2	138.6	142.1
8	113.9	120.8	130.2	135.1	138.7	142.1
9	113.9	120.8	130.2	135.0	138.5	141.8
10*	113.8	120.6	129.9	134.6	138.0	141.2
			Falling Stages			
1	129.2	134.5	141.6	145.6	148.4	150.7
2	129.1	134.4	141.3	145.2	147.9	150.2
3	129.1	134.3	141.2	145.0	147.6	149.6
4	129.1	134.3	141.2	144.9	147.6	149.6
5	129.1	134.3	141.1	144.9	147.5	149.5
6	129.1	134.2	141.0	144.8	147.4	149.4
7	123.7	132.8	139.9	143.6	146.2	148.1
8	123.7	132.8	139.9	143.7	146.2	148.1
9	123.7	132.8	139.9	143.5	146.0	147.9
10*	123.7	132.7	139.7	143.3	145.8	147.5

* Controlled elevation.

Table 8

Water-Surface Elevations, First-Stage Cofferdam

Gage No.	Water-Surface Elevations, ft NGVD, for Discharge, 1,000 cfs					
	30	60	100	130	160	198
1	128.7	131.3	139.1	143.9	147.4	150.6
2	128.7	131.2	138.8	143.4	146.8	150.1
3	128.6	131.1	138.8	143.4	146.8	149.9
4	113.8	125.8	136.1	141.1	144.8	147.7
4B	114.1	126.3	136.8	141.8	145.5	148.5
5	114.0	126.0	136.6	141.6	145.2	148.1
6	114.0	126.0	136.7	141.6	145.1	148.0
7	113.9	125.7	136.4	141.2	144.6	147.4
8	113.9	125.8	136.3	141.1	144.6	147.4
9	113.9	125.8	136.3	141.2	144.7	147.4
10*	113.8	125.8	136.2	141.1	144.5	147.3

* Controlled elevation.

Table 9

Water-Surface Elevations, Second-Stage Cofferdam

Gage No.	Water-Surface Elevations, ft NGVD, for Discharge, 1,000 cfs					
	30	60	100	130	160	198
			Plan A			
1	132.0	136.3	145.7	150.0	153.0	154.4
2	132.0	136.1	145.4	149.8	152.7	154.0
3	132.0	136.1	145.4	149.6	152.5	153.7
4	131.9	136.0	145.3	149.5	152.4	153.4
5	131.9	136.0	145.3	149.5	152.4	153.4
6	131.8	135.7	144.6	148.7	151.7	153.1
7	113.7	125.5	135.9	140.7	144.4	147.5
8	113.7	125.4	135.8	140.6	144.3	147.4
9	113.9	125.9	136.1	141.1	144.6	147.5
10*	113.8	125.8	136.2	141.1	144.5	147.3
			Plan B			
1	132.0	136.3	145.7	150.0	153.0	154.4
2	132.0	136.2	145.4	149.8	152.7	154.0
3	132.9	136.1	145.4	149.6	152.5	153.7
4	131.9	136.0	145.3	149.5	152.4	153.4
5	131.9	136.0	145.3	149.5	152.4	153.4
6	131.7	135.5	144.6	148.7	151.7	153.1
7	113.8	125.9	135.9	140.7	144.4	147.5
8	113.5	125.4	135.8	140.6	144.3	147.4
9	113.7	125.9	136.1	141.1	144.6	147.5
10*	113.8	125.8	136.2	141.1	144.5	147.3
			Plan C			
1	132.0	136.2	145.8	150.2	152.9	155.6
2	132.0	136.0	145.6	149.9	152.6	155.2
3	131.9	135.9	145.5	149.6	152.3	154.9
4	131.9	135.9	145.4	149.6	152.3	154.8
5	131.9	135.9	145.4	149.6	152.3	154.9

(Continued)

* Controlled elevation.

Table 9 (Concluded)

Gage No.	Water-Surface Elevations, ft NGVD, for Discharge, 1,000 cfs					
	30	60	100	130	160	198
			Plan C (Continued)			
6	131.7	135.5	144.6	148.7	151.4	154.0
7	113.8	125.9	136.4	141.6	145.2	148.6
8	113.5	125.5	135.5	140.4	144.3	146.7
9	113.7	125.7	136.1	141.0	144.6	147.4
10*	113.8	125.8	136.2	141.1	144.5	147.3
			Plan D			
1	132.4	136.6	145.9	150.3	152.9	155.7
2	132.3	136.5	145.7	150.0	152.6	155.3
3	132.3	136.5	145.6	149.7	152.5	154.9
4	132.3	136.5	145.5	149.7	152.4	154.9
5	132.3	136.4	145.6	149.7	152.4	154.9
6	132.1	136.0	144.7	148.7	151.4	154.0
7	113.9	126.0	136.4	141.6	145.2	148.7
8	113.9	125.9	135.4	140.4	144.5	146.7
9	113.8	126.0	136.3	141.0	144.6	147.4
10*	113.8	125.8	136.2	141.1	144.5	147.3

* Controlled elevation.

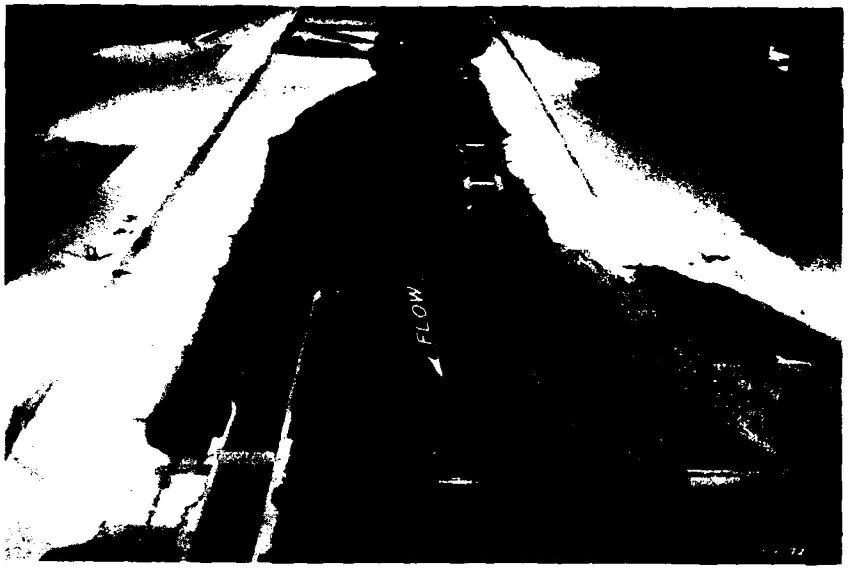


Photo 1. Plan A, looking upstream, discharge 30,000 cfs. Confetti showing current patterns approaching replacement lock and dam

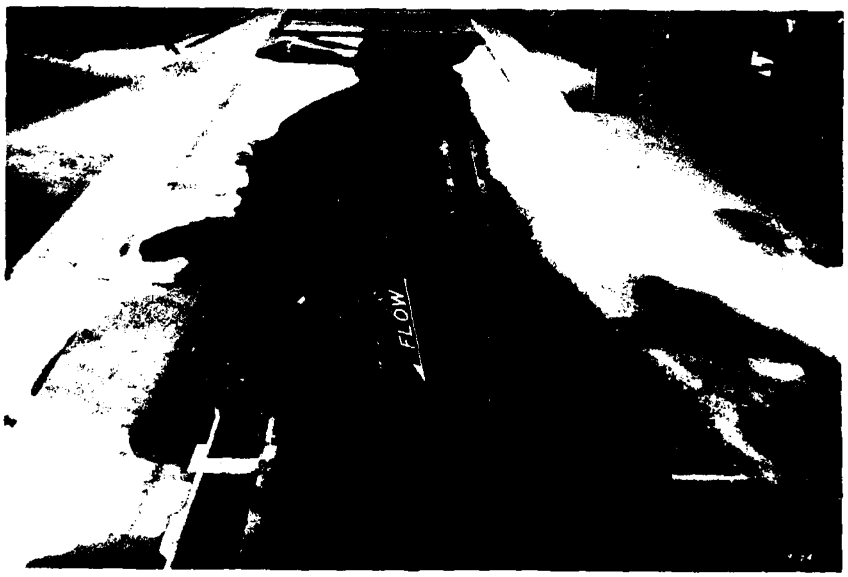


Photo 2. Plan A, looking upstream, discharge 100,000 cfs. Confetti showing current patterns approaching replacement lock and dam.

Photo 3. Plan A, looking downstream, discharge 30,000 cfs. Confetti showing current patterns approaching replacement lock and dam

Photo 4. Plan A, looking downstream, discharge 100,000 cfs. Confetti showing current patterns approaching replacement lock and dam

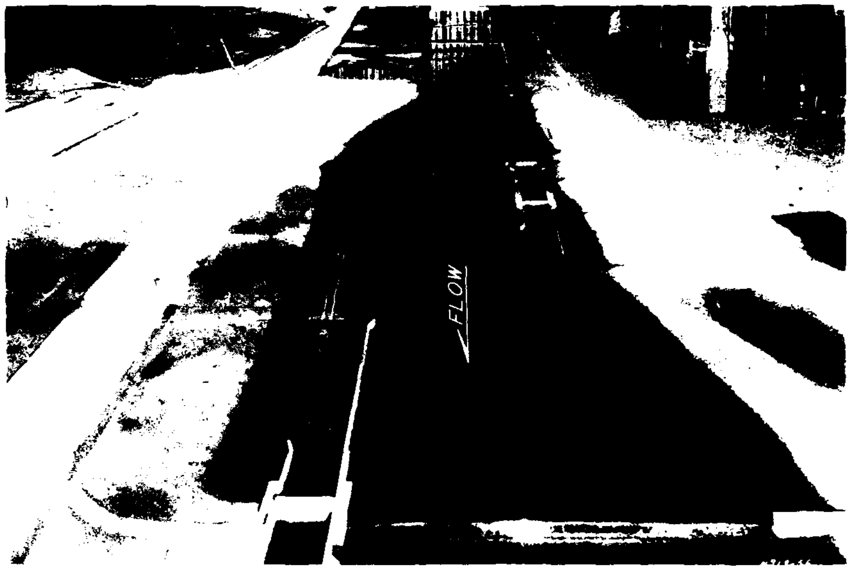


Photo 5. Plan A, looking upstream, discharge 30,000 cfs. Path of downbound tow approaching replacement lock

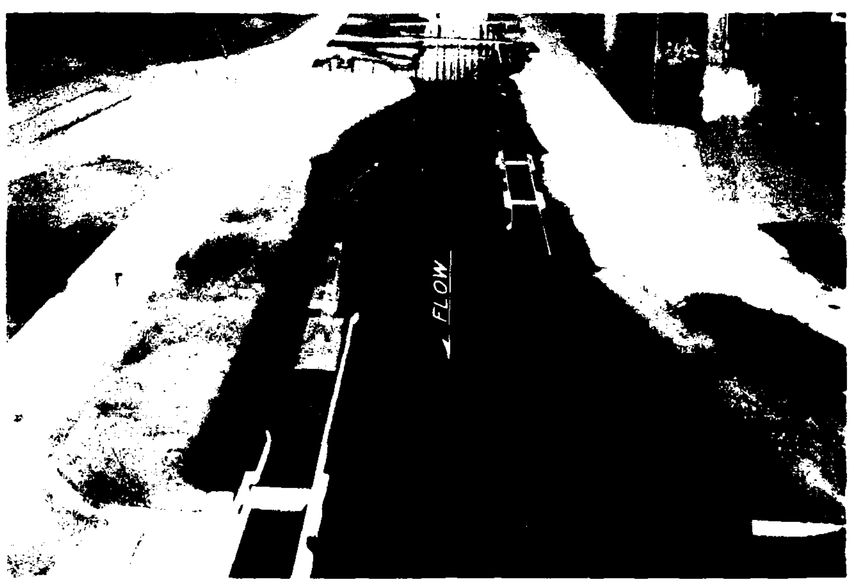


Photo 6. Plan A, looking upstream, discharge 60,000 cfs. Path of downbound tow approaching replacement lock

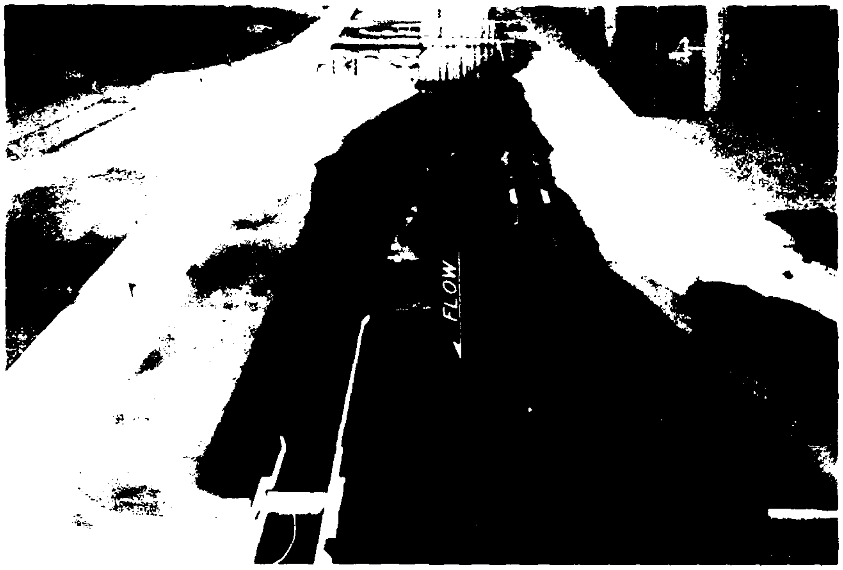


Photo 7. Plan A, looking upstream, discharge 100,000 cfs. Path of downbound tow approaching replacement lock. Note tendency for tow to be moved riverward of guard wall

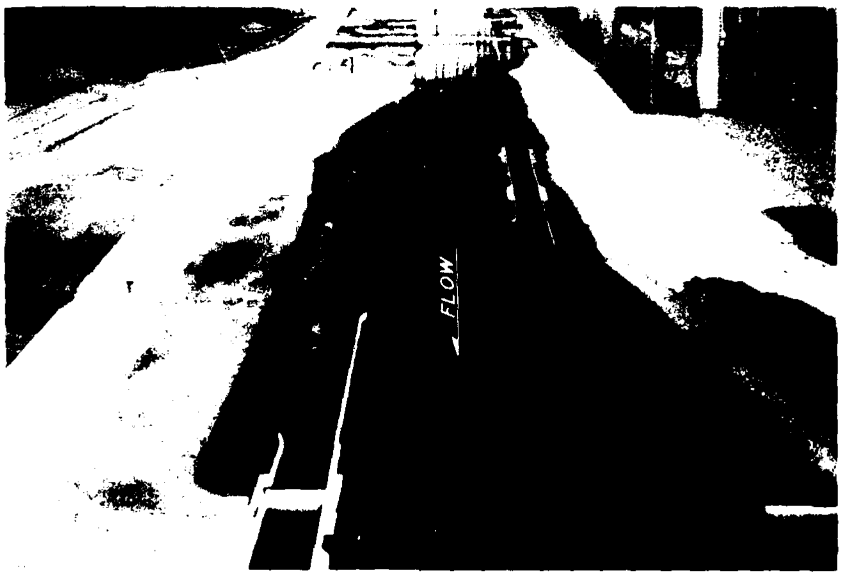


Photo 8. Plan A, looking upstream, discharge 100,000 cfs. Path of downbound tow flanking to approach replacement lock

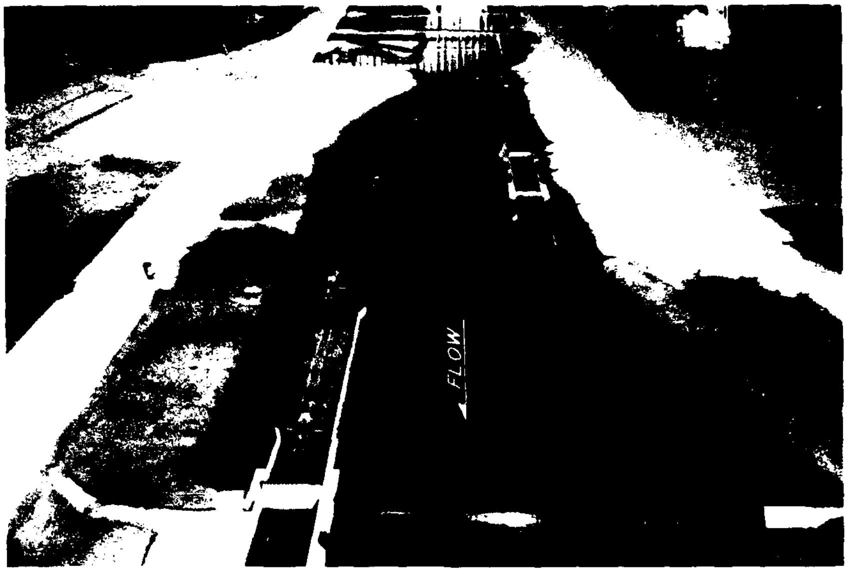


Photo 9. Plan A, looking upstream, discharge 30,000 cfs. Path of upbound tow leaving replacement lock

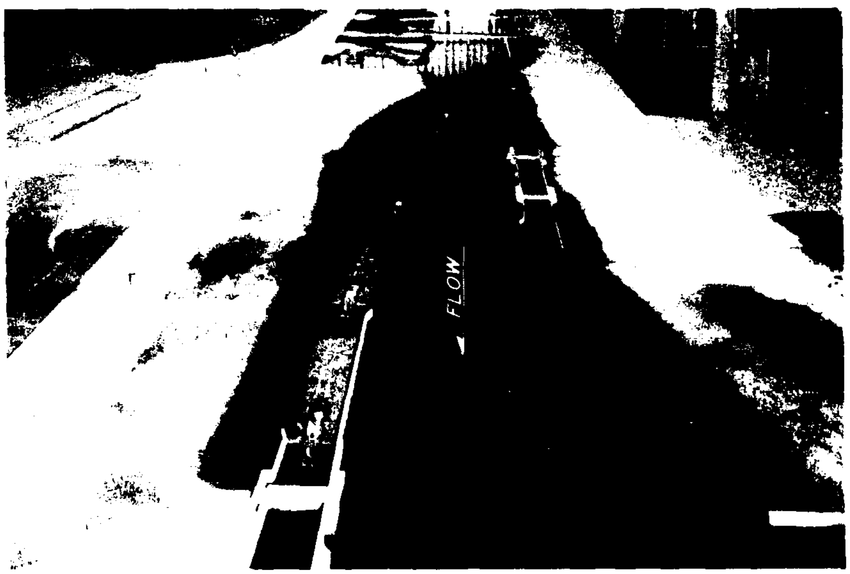


Photo 10. Plan A, looking upstream, discharge 60,000 cfs. Path of upbound tow leaving replacement lock

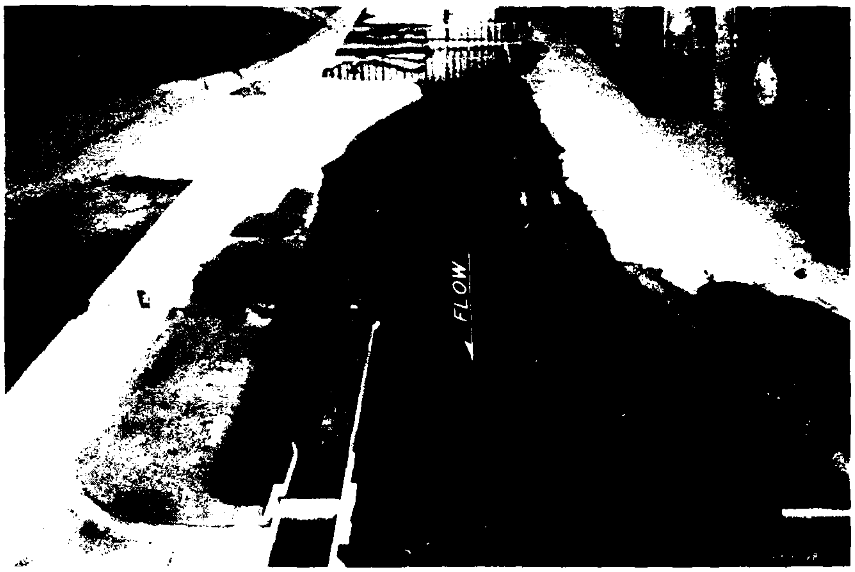


Photo 11. Plan A, looking upstream, discharge 100,000 cfs. Path of upbound tow leaving replacement lock

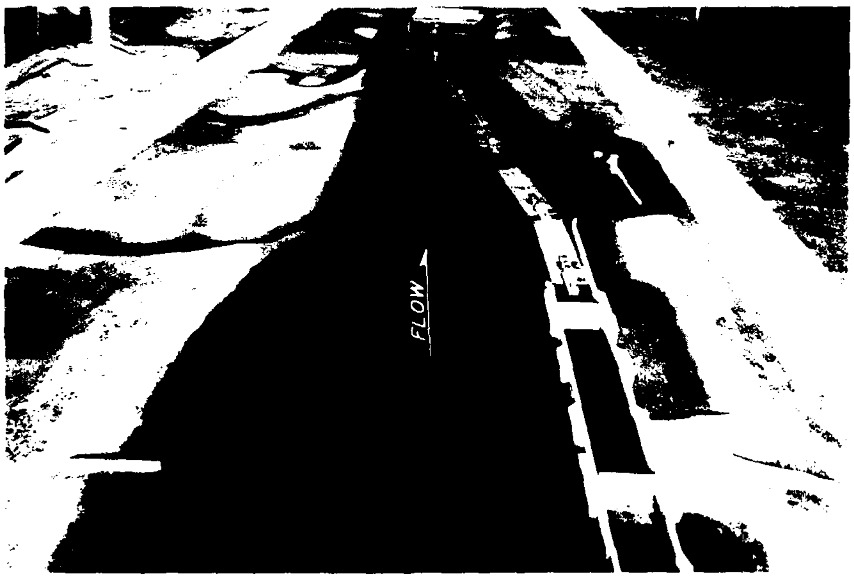


Photo 12. Plan A, looking downstream, discharge 30,000 cfs. Path of downbound tow leaving replacement lock

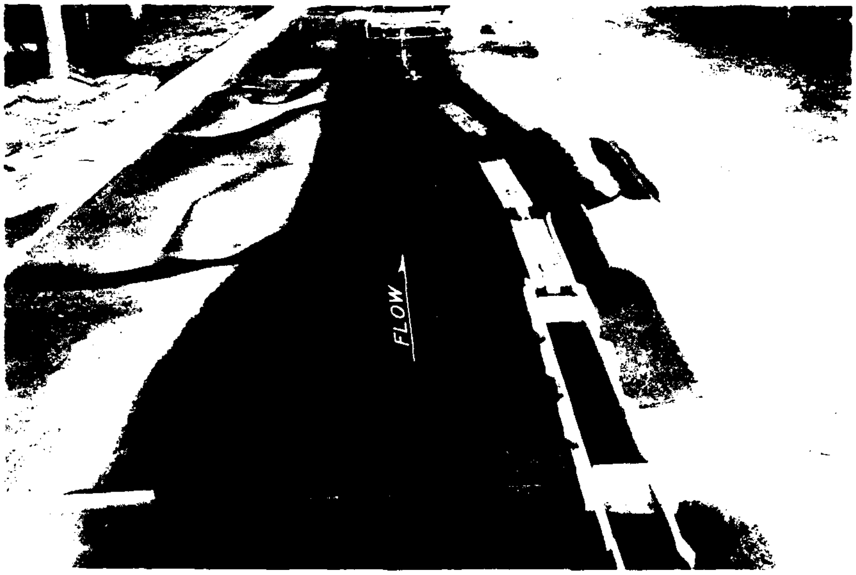


Photo 13. Plan A, looking downstream, discharge 60,000 cfs. Path of downbound tow leaving replacement lock

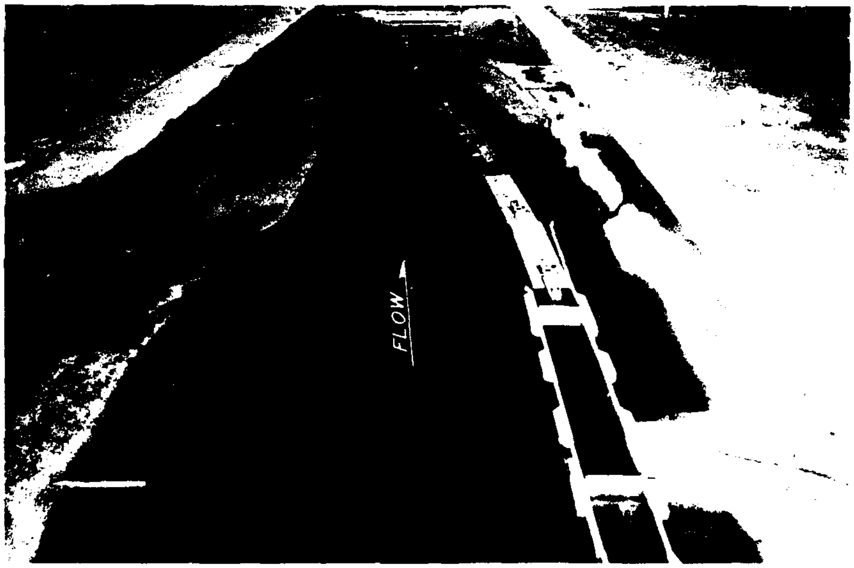


Photo 14. Plan A, looking downstream, discharge 100,000 cfs. Path of downbound tow leaving replacement lock

Photo 15. Plan A, looking downstream, discharge 30,000 cfs. Path of upbound tow entering replacement lock

Photo 16. Plan A, looking downstream, discharge 60,000 cfs. Path of upbound tow entering replacement lock

Photo 17. Plan A, looking downstream, discharge 100,000 cfs. Path of upbound tow entering replacement lock

Photo 18. First-stage cofferdam, looking downstream

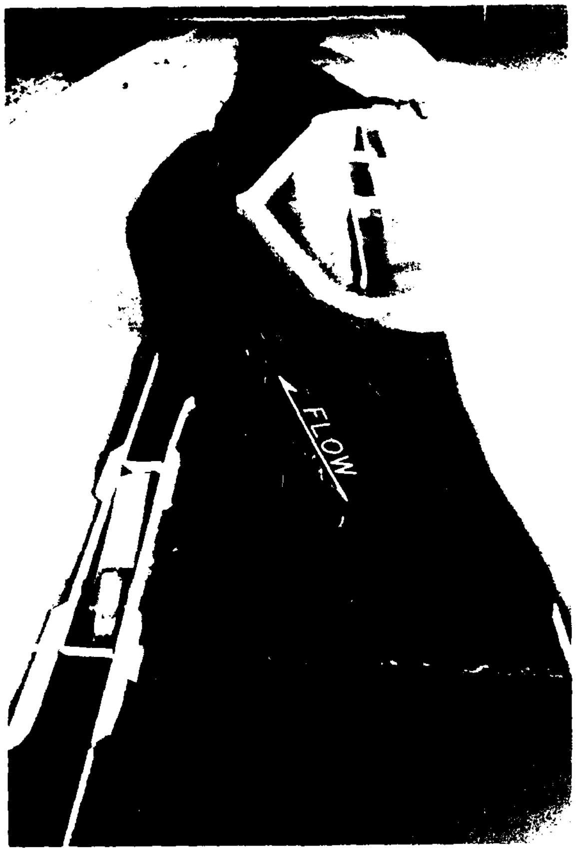


Photo 19. First-stage cofferdam, looking downstream, discharge 30,000 cfs. Confetti showing surface current patterns approaching the cofferdam

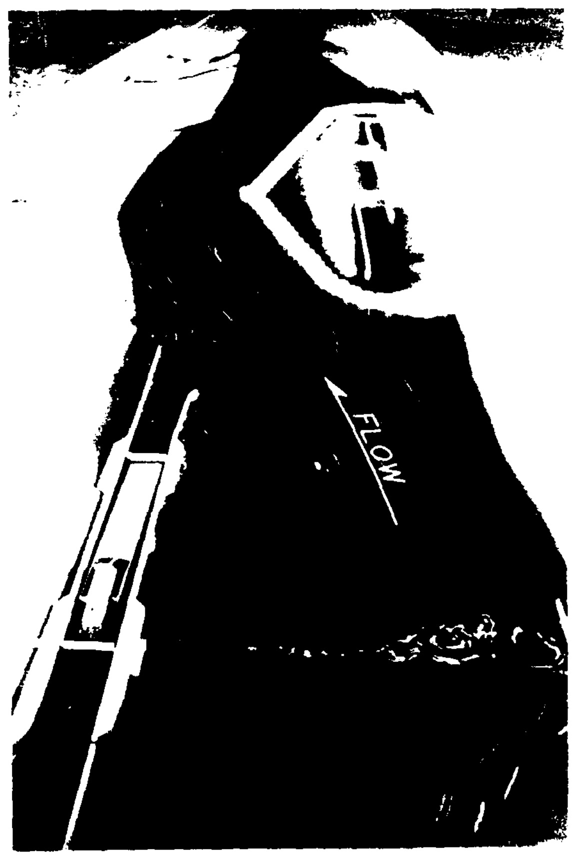


Photo 20. First-stage cofferdam, looking downstream, discharge 60,000 cfs. Confetti showing surface current patterns approaching the cofferdam

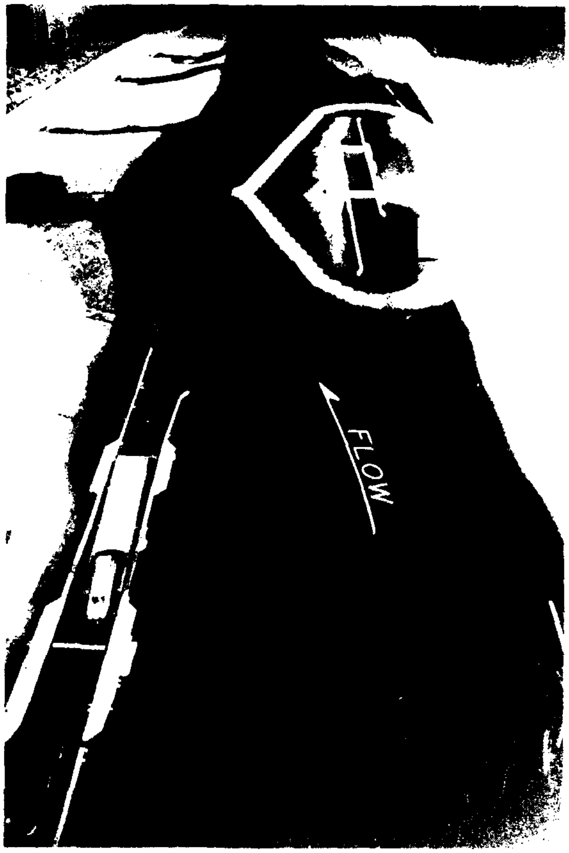


Photo 21. First-stage cofferdam, looking downstream, discharge 100,000 cfs. Confetti showing surface current patterns approaching the cofferdam

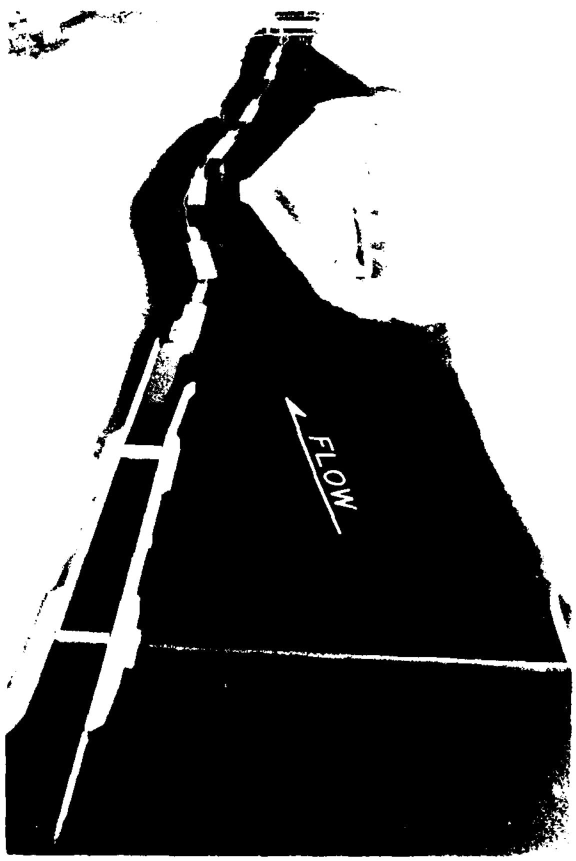


Photo 22. First-stage cofferdam, looking downstream, discharge 30,000 cfs. Path of upbound tow navigating the reach

Photo 23. First-stage cofferdam, looking downstream, discharge 60,000 cfs. Path of upbound tow navigating the reach

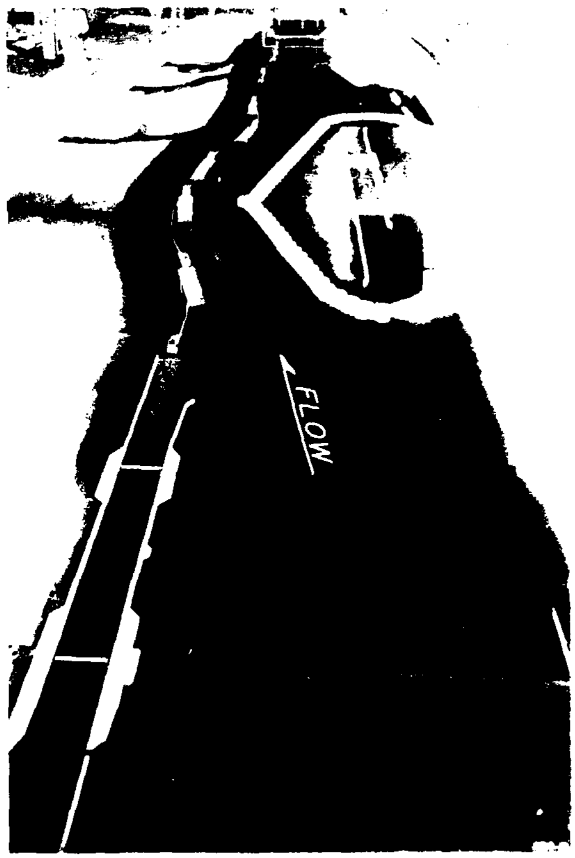


Photo 24. First-stage cofferdam, looking downstream, discharge 100,000 cfs. Path of upbound tow navigating the reach

Photo 25. First-stage cofferdam, looking downstream, discharge 30,000 cfs. Path of downbound tow navigating the reach

Photo 26. First-stage cofferdam, looking downstream, discharge 60,000 cfs. Path of downbound tow navigating the reach

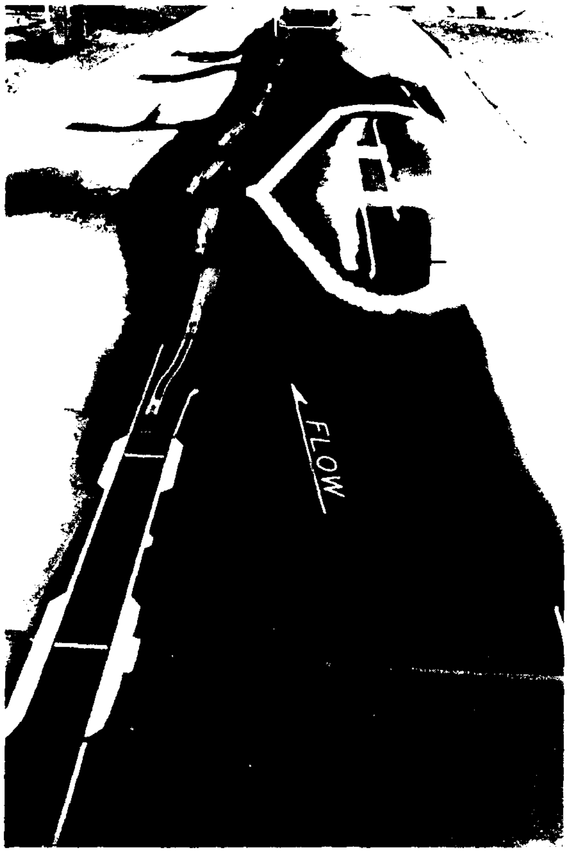


Photo 27. First-stage cofferdam, looking downstream, discharge 100,000 cfs. Path of downbound tow navigating the reach

Photo 28. Second-stage cofferdam, Plan C, looking upstream, discharge 60,000 cfs. Confetti showing surface current patterns approaching the lock and cofferdam

Photo 29. Second-stage cofferdam, Plan C, looking downstream, discharge 60,000 cfs. Confetti showing surface current patterns downstream of cofferdam

Photo 30. Second-stage cofferdam, Plan C, looking upstream, discharge 60,000 cfs. Path of downbound tow approaching replacement lock

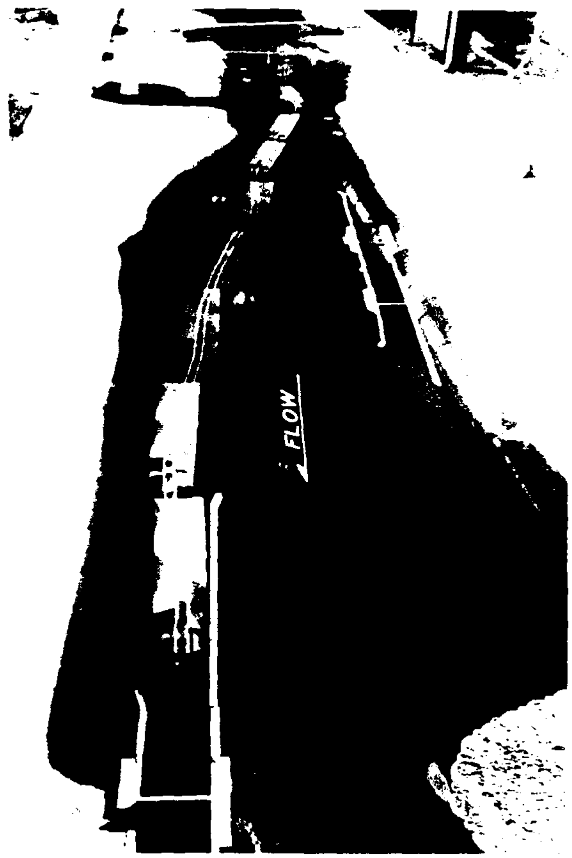


Photo 31. Second-stage cofferdam, Plan C, looking upstream, discharge 60,000 cfs. Path of upbound tow leaving replacement lock

Photo 32. Second-stage cofferdam, Plan C, looking downstream, discharge 60,000 cfs. Path of downbound tow leaving replacement lock

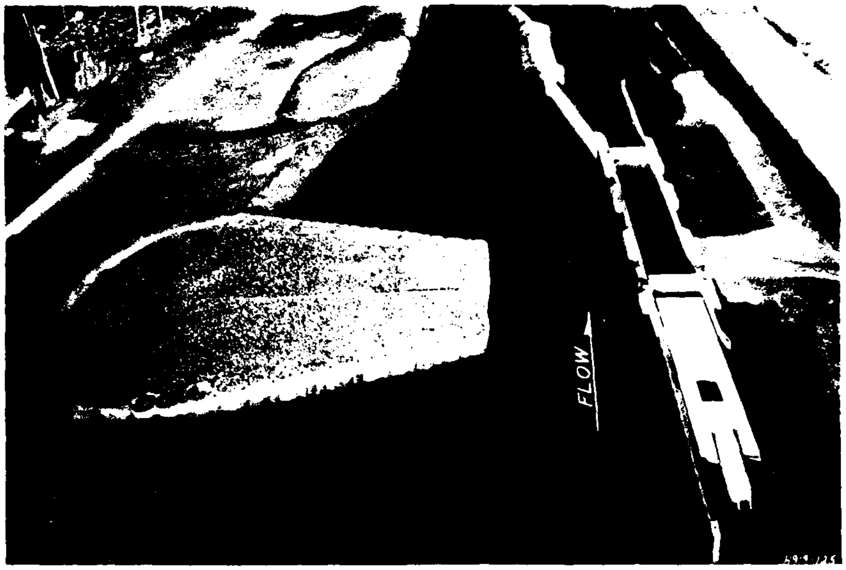


Photo 33. Second-stage cofferdam, Plan D, looking downstream

Photo 34. Second-stage cofferdam, Plan D, looking upstream, discharge 60,000 cfs. Confetti showing surface current patterns approaching ti lock and cofferdam

Photo 35. Second-stage cofferdam, Plan D, looking downstream, discharge 60,000 cfs. Confetti showing surface current patterns downstream of cofferdam

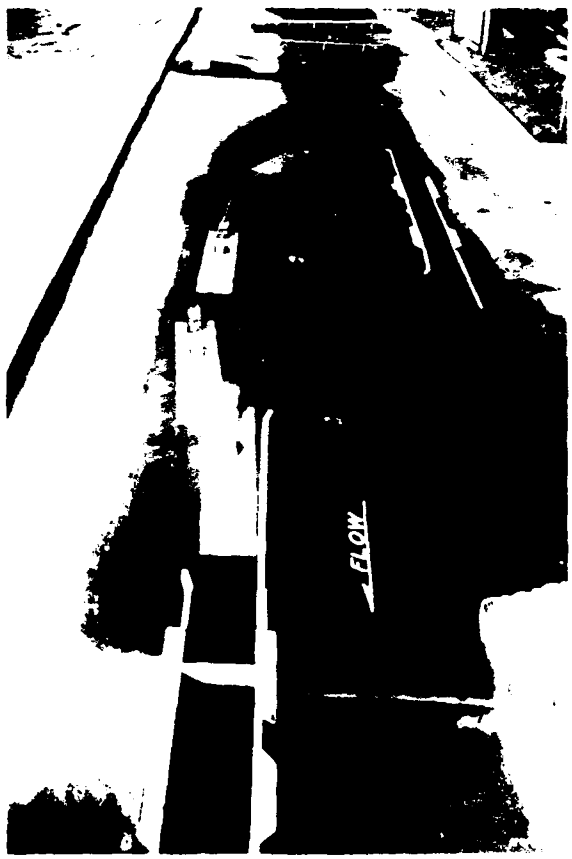


Photo 36. Second-stage cofferdam, Plan D, looking upstream, discharge 60,000 cfs. Path of downbound tow approaching replacement lock

Photo 37. Second-stage cofferdam, Plan D, looking upstream, discharge 100,000 cfs. Path of downbound tow flanking to approach replacement lock

Photo 38. Second-stage cofferdam, Plan D, looking upstream, discharge 60,000 cfs. Path of upbound tow leaving replacement lock

Photo 39. Second-stage cofferdam, Plan D, looking downstream, discharge 60,000 cfs. Path of downbound tow leaving replacement lock

Photo 40. Second-stage cofferdam, Plan D, looking downstream, discharge 60,000 cfs. Path of upbound tow approaching replacement lock

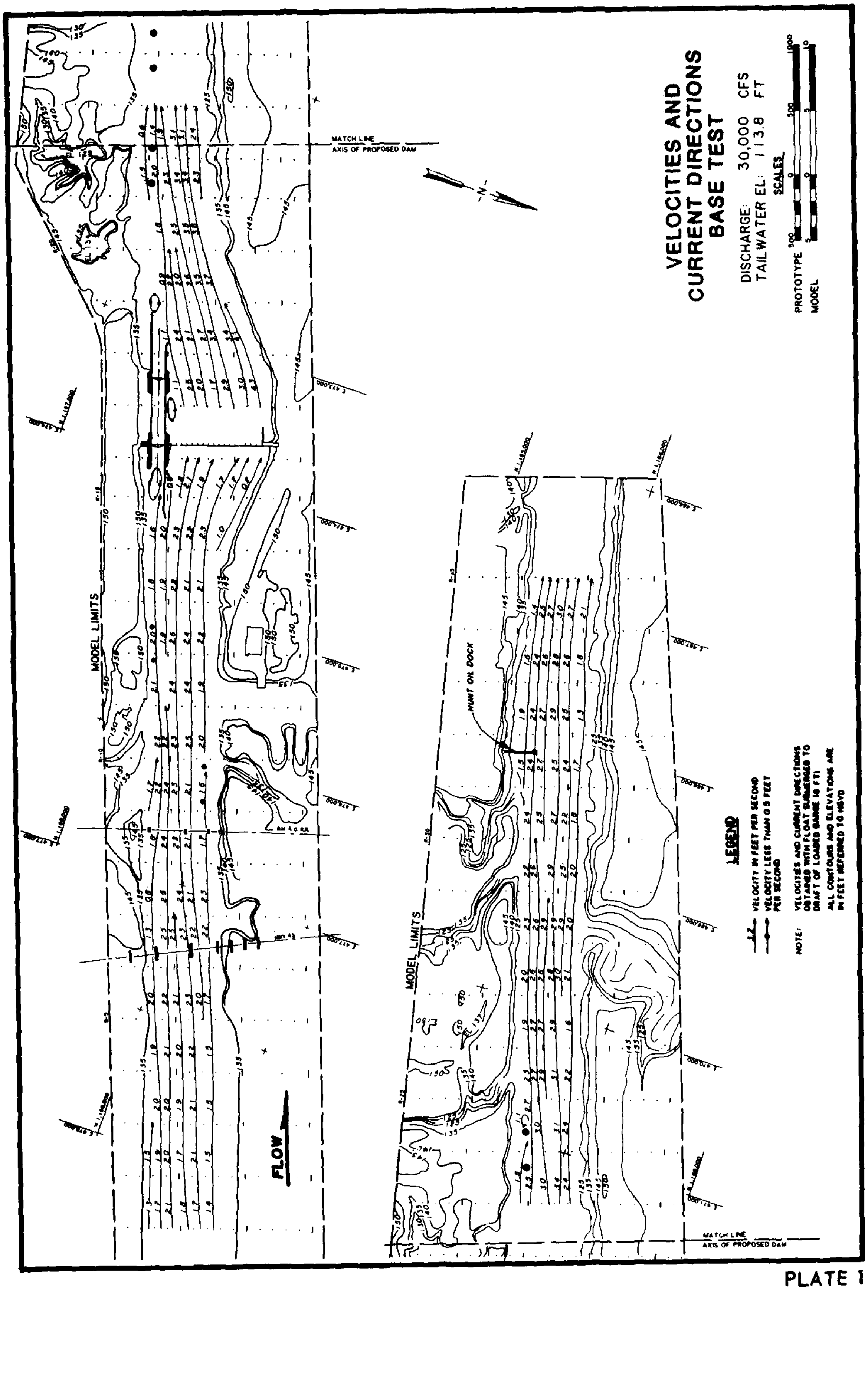
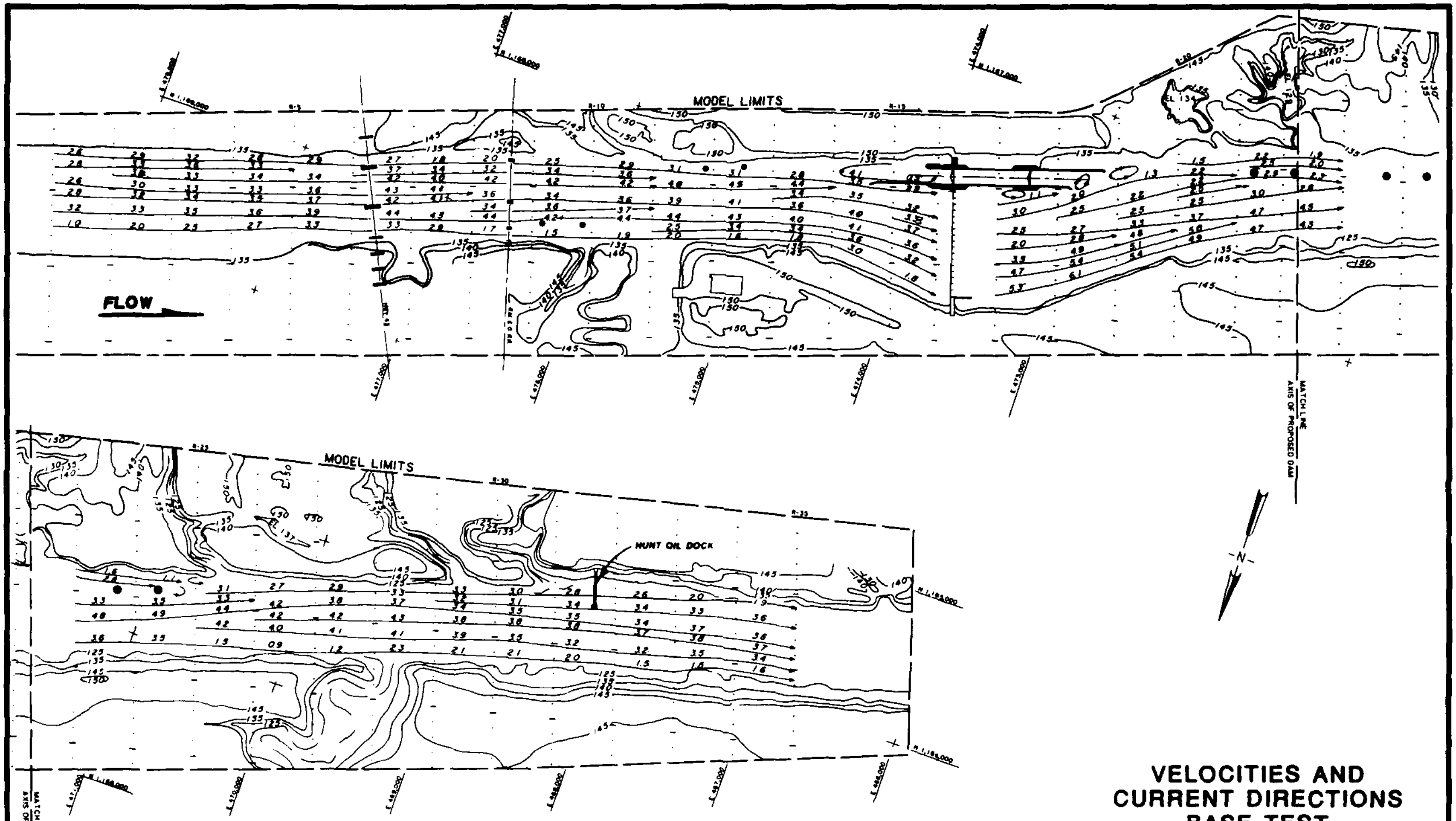

VELOCITIES AND
CURRENT DIRECTIONS
BASE TEST
DISCHARGE: 30,000 CFS
TAILWATER EL: 113.8 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
MATCH LINE
AXIS OF PROPOSED DAM
FLOW
HUNT OIL DOCK

PLATE 1



LEGEND

3.2 VELOCITY IN FEET PER SECOND

VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS BASE TEST

DISCHARGE: 60,000 CFS

TAILWATER EL: 125.8 FT

SCALES

PROTOTYPE 500 0 500 1000

MODEL 5 0 5 10

PLATE 2

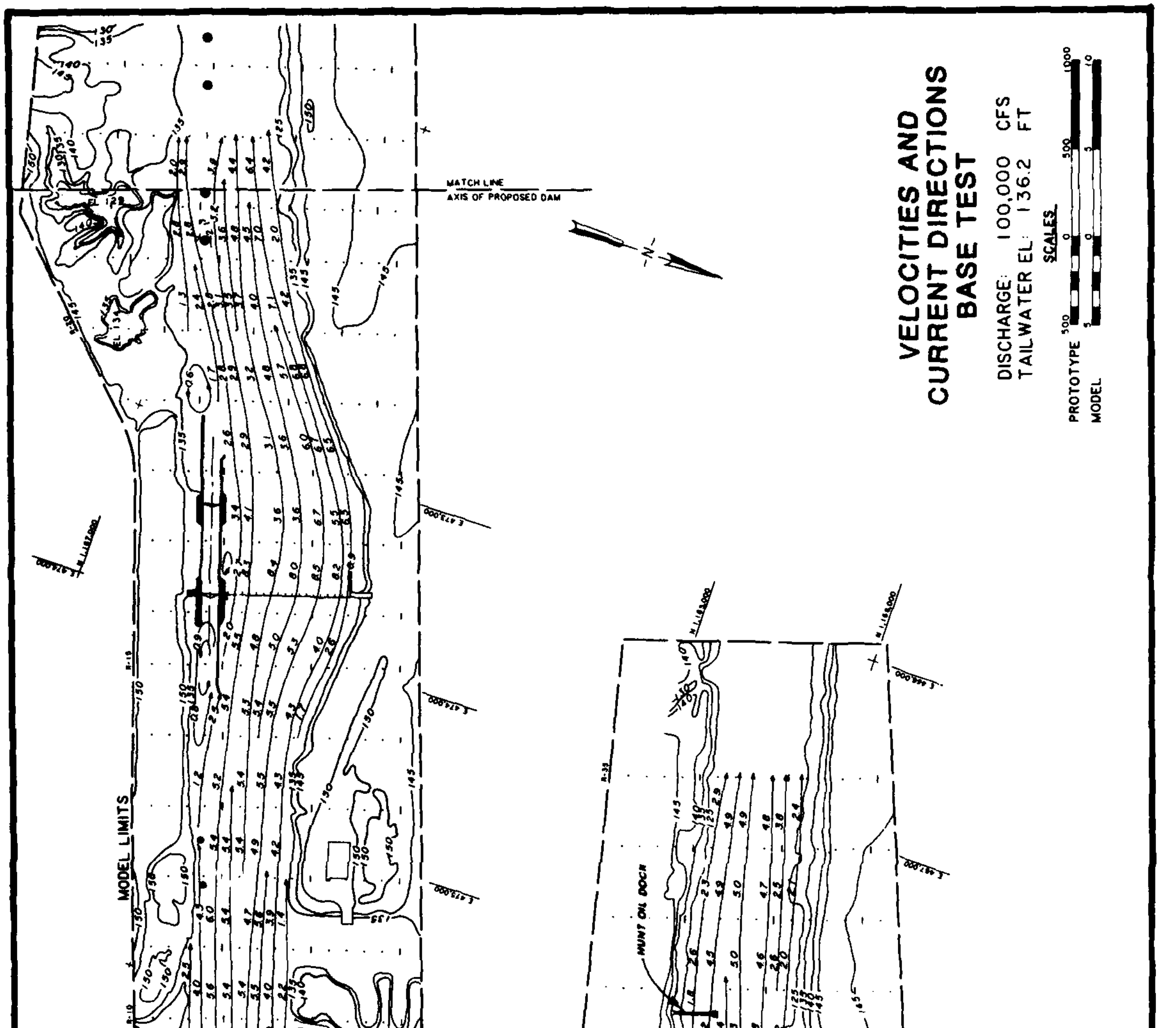

VELOCITIES AND
CURRENT DIRECTIONS
BASE TEST
DISCHARGE: 100,000 CFS
TAILWATER EL: 136.2 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MATCH LINE
AXIS OF PROPOSED DAM
MODEL LIMITS
HUNT OIL DOCK
FLOW
N

PLATE 3

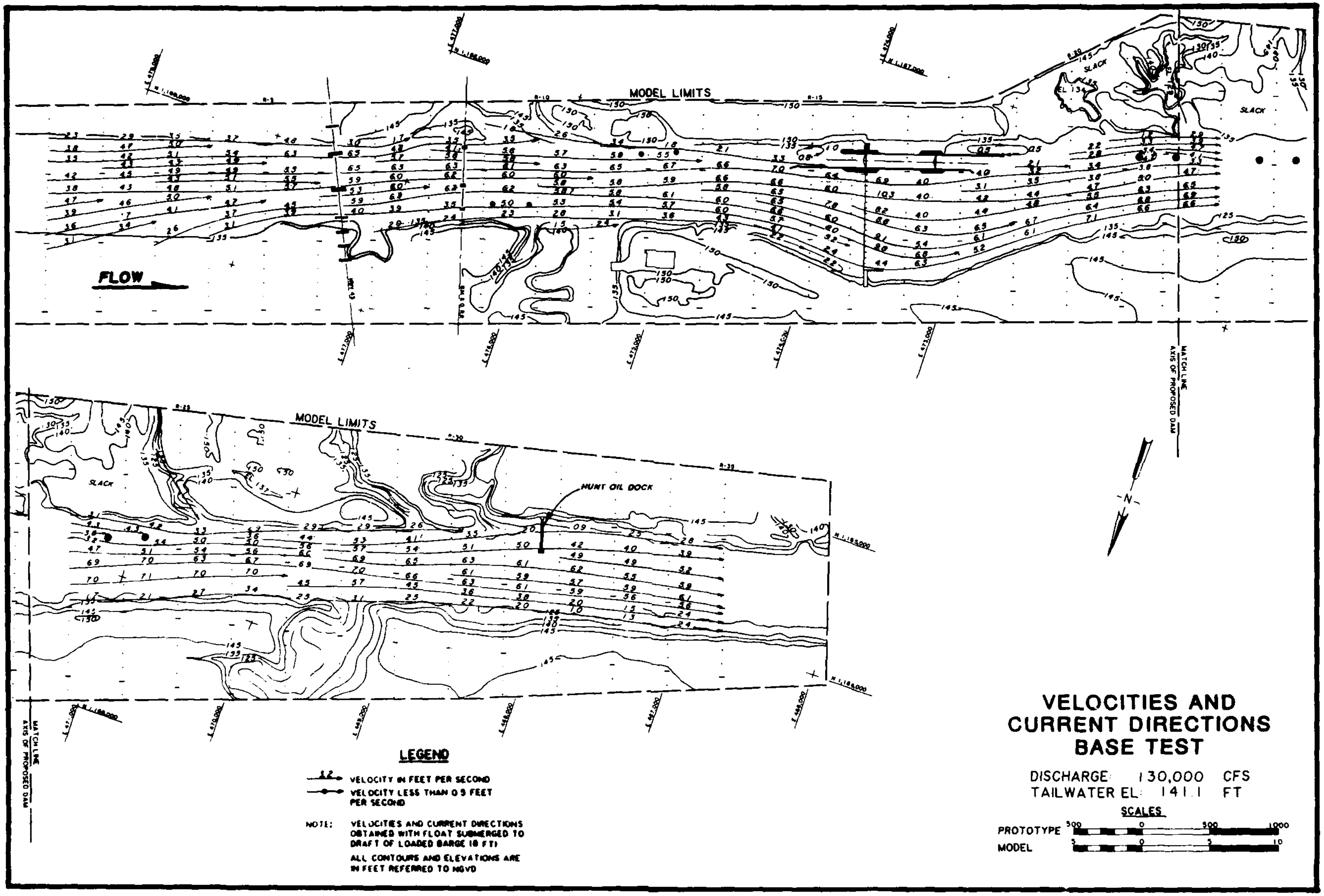
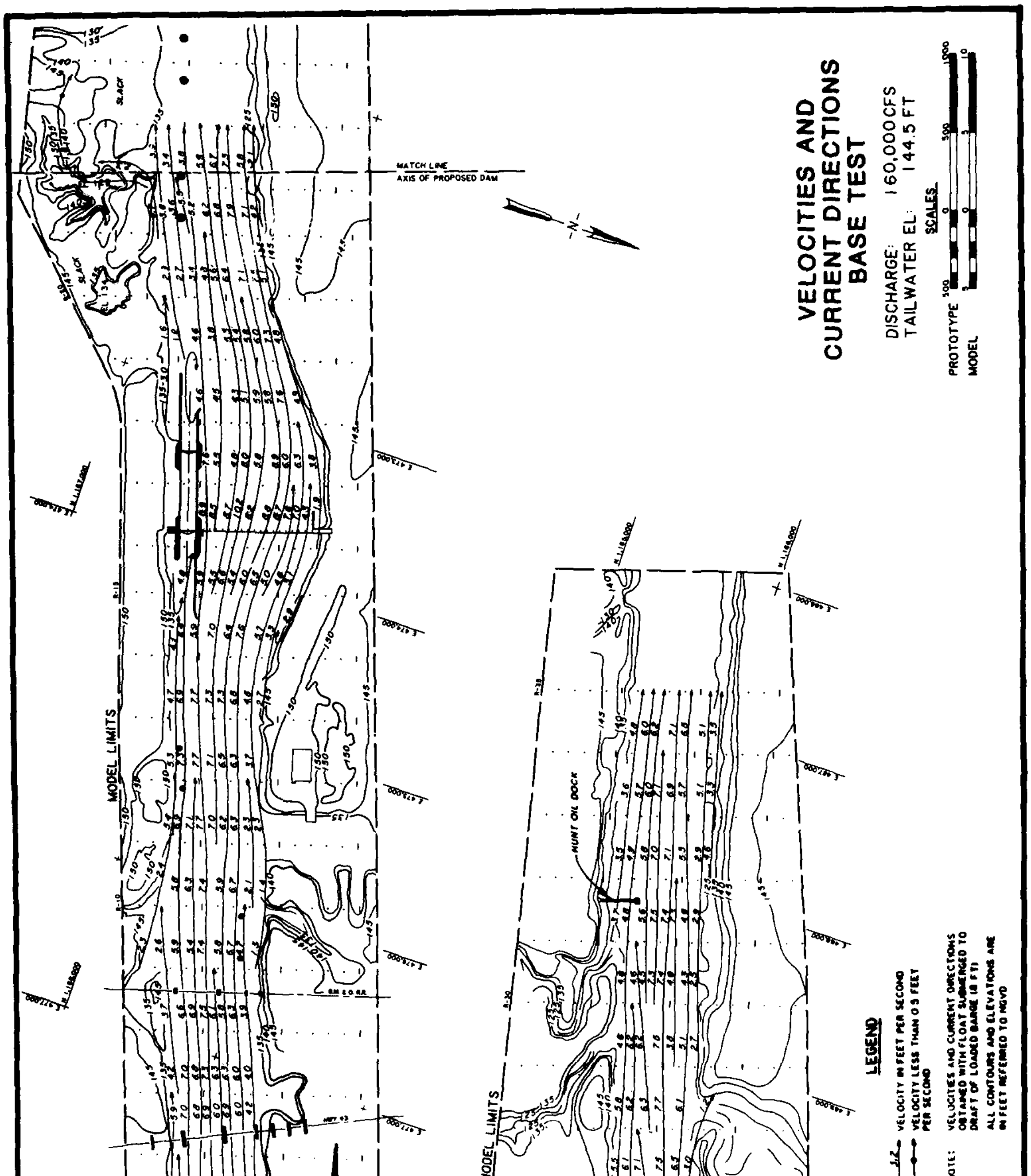

MODEL LIMITS
FLOW
HUNT OIL DOCK
SLACK
MATCH LINE
AXIS OF PROPOSED DAM
N
VELOCITIES AND
CURRENT DIRECTIONS
BASE TEST
DISCHARGE: 130,000 CFS
TAILWATER EL: 141.1 FT
SCALES
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

PLATE 4


VELOCITIES AND CURRENT DIRECTIONS
BASE TEST
DISCHARGE: 160,000 CFS
TAILWATER EL: 144.5 FT
SCALES
PROTOTYPE
MODEL
MATCH LINE
AXIS OF PROPOSED DAM
MODEL LIMITS
FLOW
SLACK
HUNT OIL DOCK
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

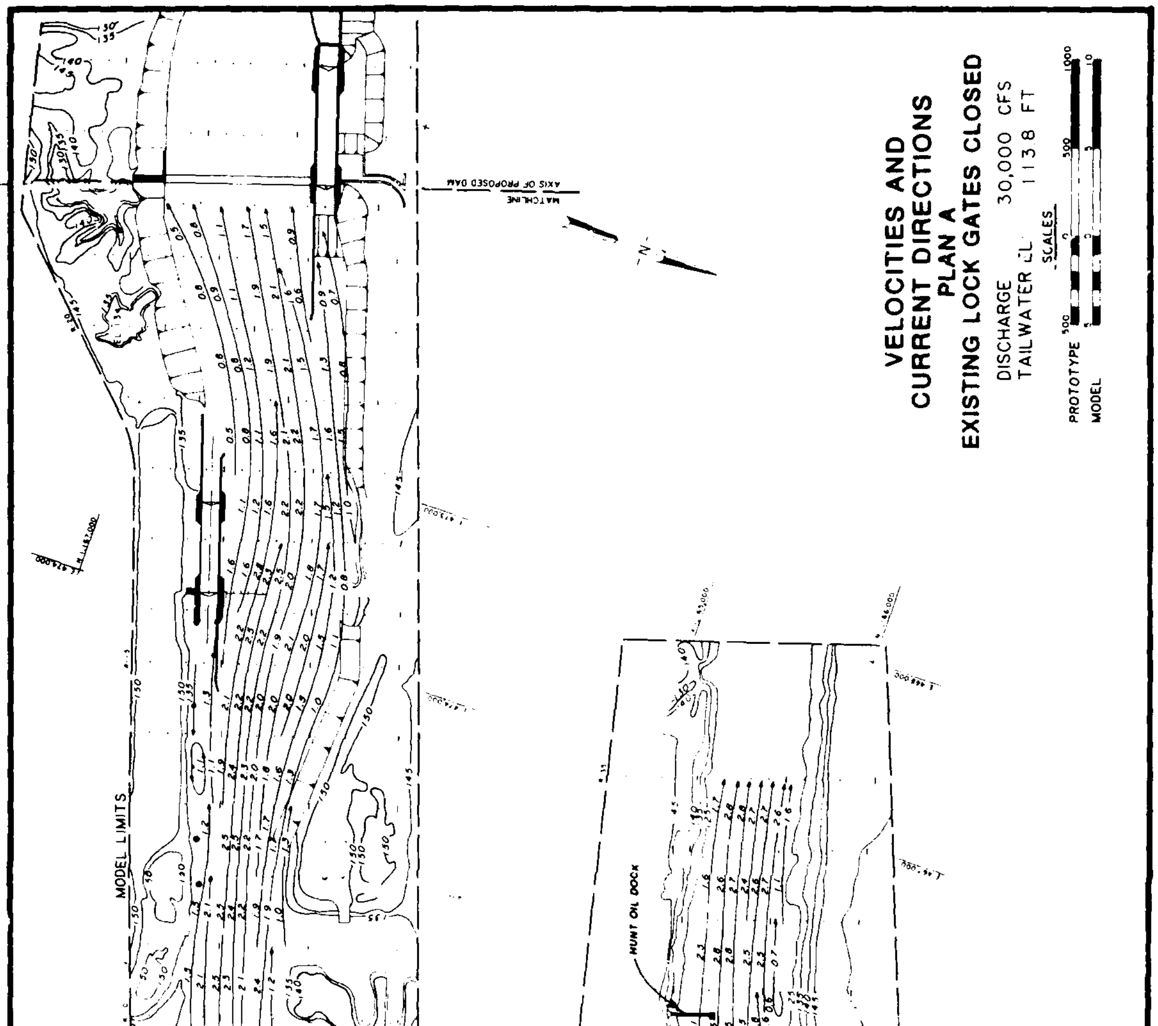
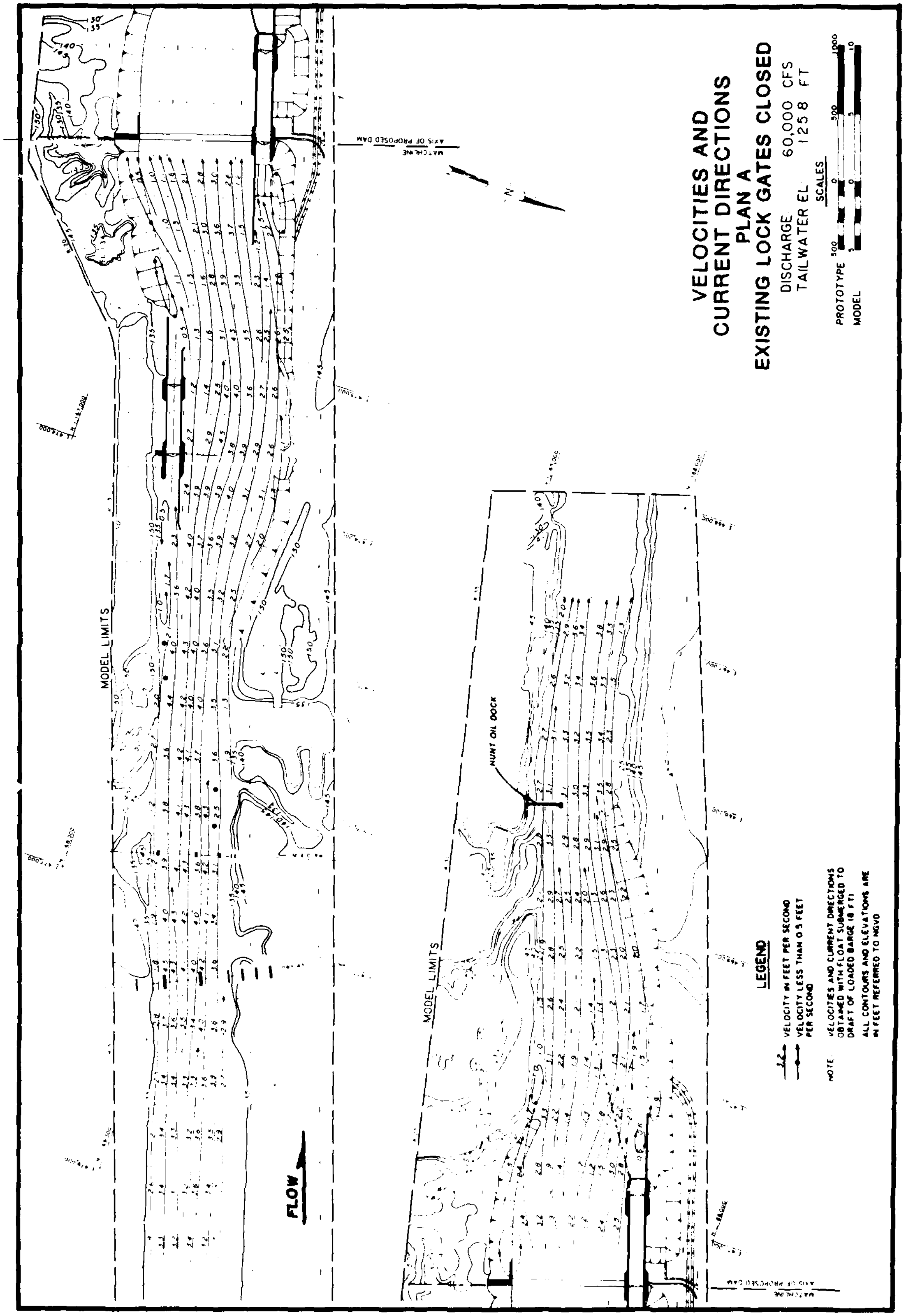

VELOCITIES AND
CURRENT DIRECTIONS
PLAN A
EXISTING LOCK GATES CLOSED
DISCHARGE 30,000 CFS
TAILWATER EL 1138 FT
SCALES
PROTOTYPE 500 0 500 1000
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
FLOW
HUNT OIL DOCK
AXIS OF PROPOSED DAM
MATCHLINE
N

PLATE 6


VELOCITIES AND
CURRENT DIRECTIONS
PLAN A
EXISTING LOCK GATES CLOSED
DISCHARGE 60,000 CFS
TAILWATER EL 125.8 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
MODEL LIMITS
AXIS OF PROPOSED DAM
MATCHLINE
AXIS OF PROPOSED DAM
MATCHLINE
HUNT OIL DOCK
FLOW
N

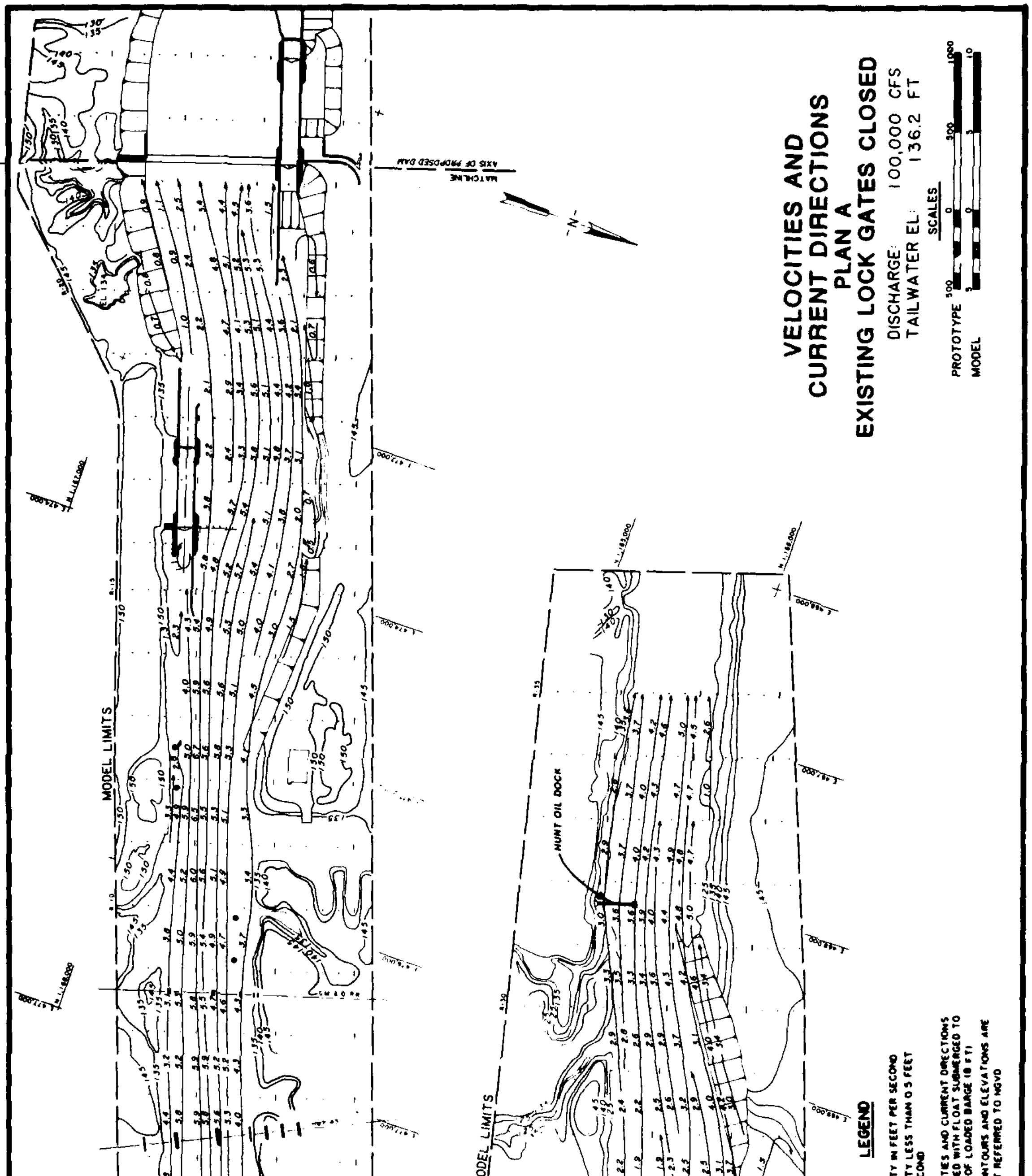

VELOCITIES AND
CURRENT DIRECTIONS
PLAN A
EXISTING LOCK GATES CLOSED
DISCHARGE: 100,000 CFS
TAILWATER EL: 136.2 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE:
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
FLOW
HUNT OIL DOCK
AXIS OF PROPOSED DAM
MATCHLINE

PLATE 8

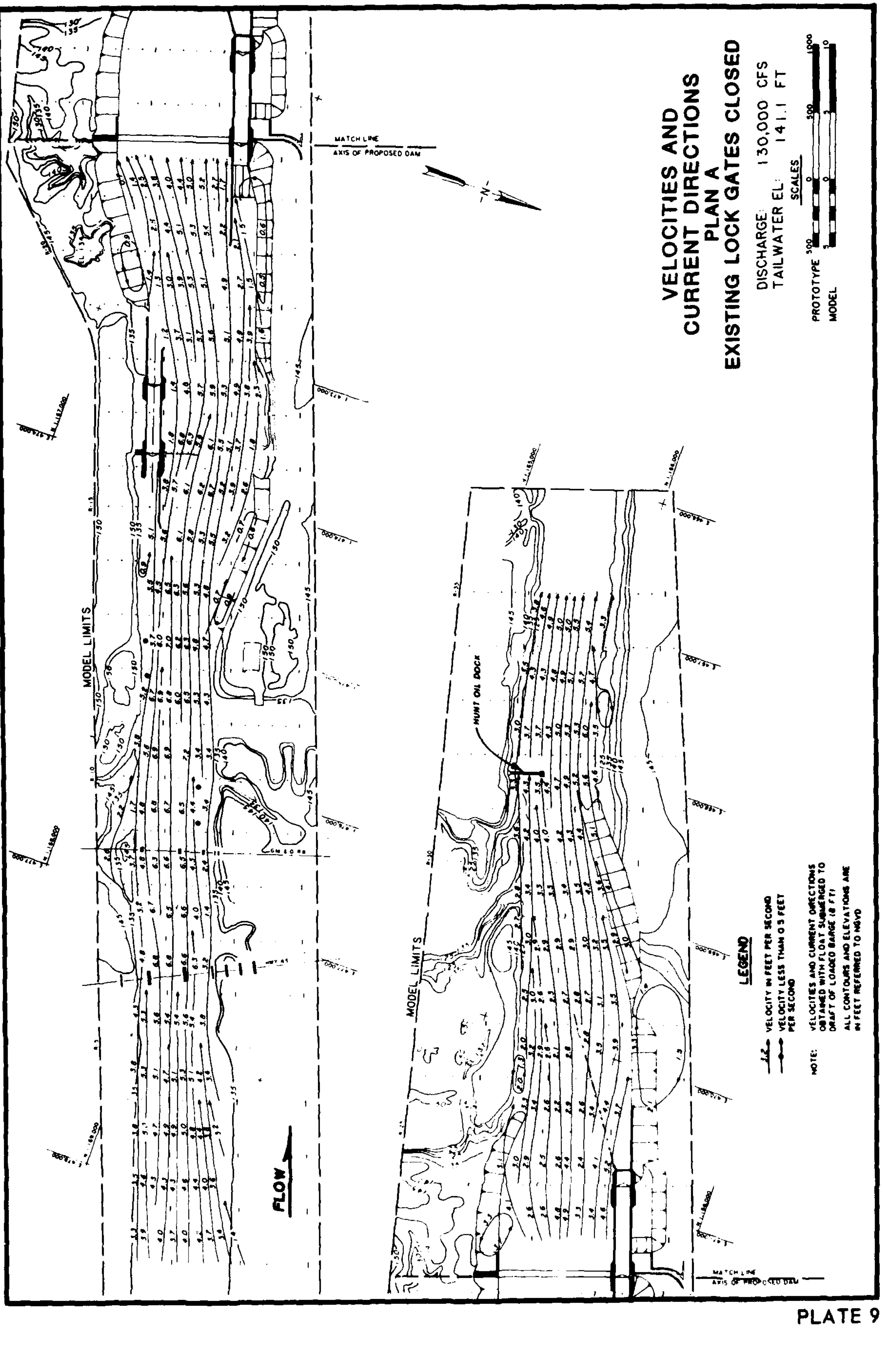
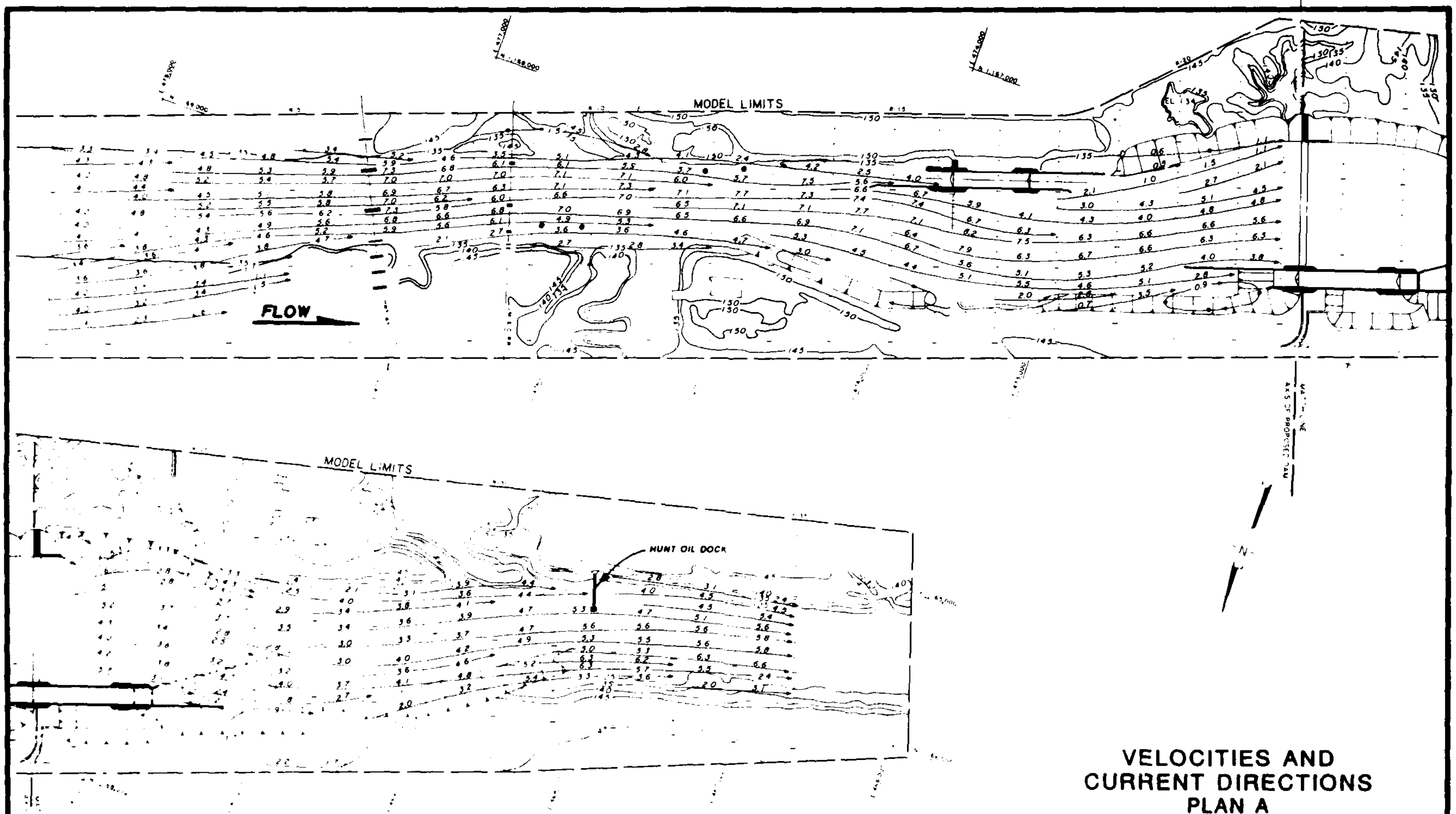

VELOCITIES AND
CURRENT DIRECTIONS
PLAN A
EXISTING LOCK GATES CLOSED
DISCHARGE: 130,000 CFS
TAILWATER EL: 141.1 FT
SCALES
PROTOTYPE
MODEL
MATCH LINE
AXIS OF PROPOSED DAM
MODEL LIMITS
FLOW
HUNT OIL DOCK
N
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

PLATE 9



VELOCITIES AND CURRENT DIRECTIONS PLAN A EXISTING LOCK GATES CLOSED

DISCHARGE 160,000 CFS
TAILWATER EL 144.5 FT

SCALES

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

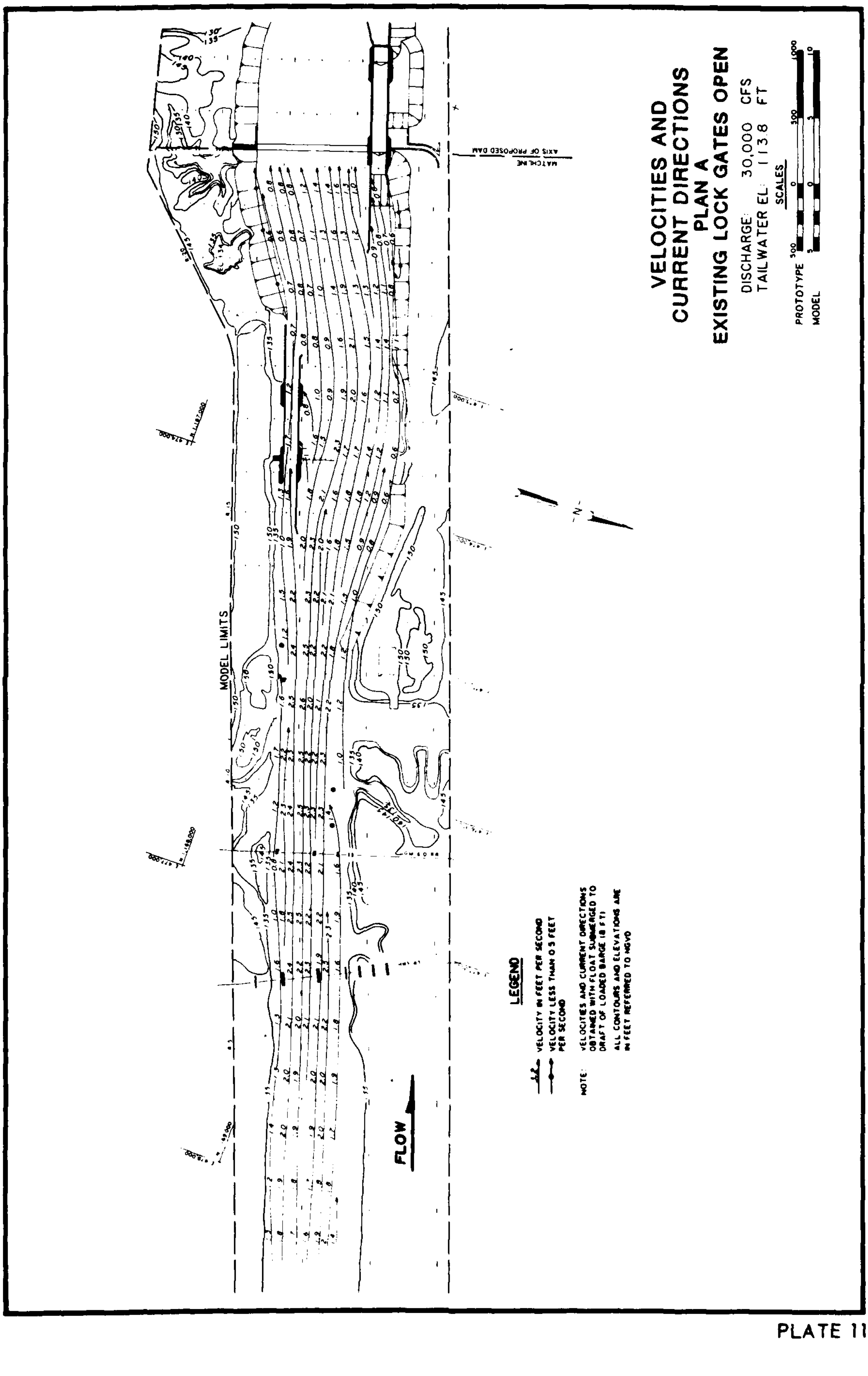
LEGEND

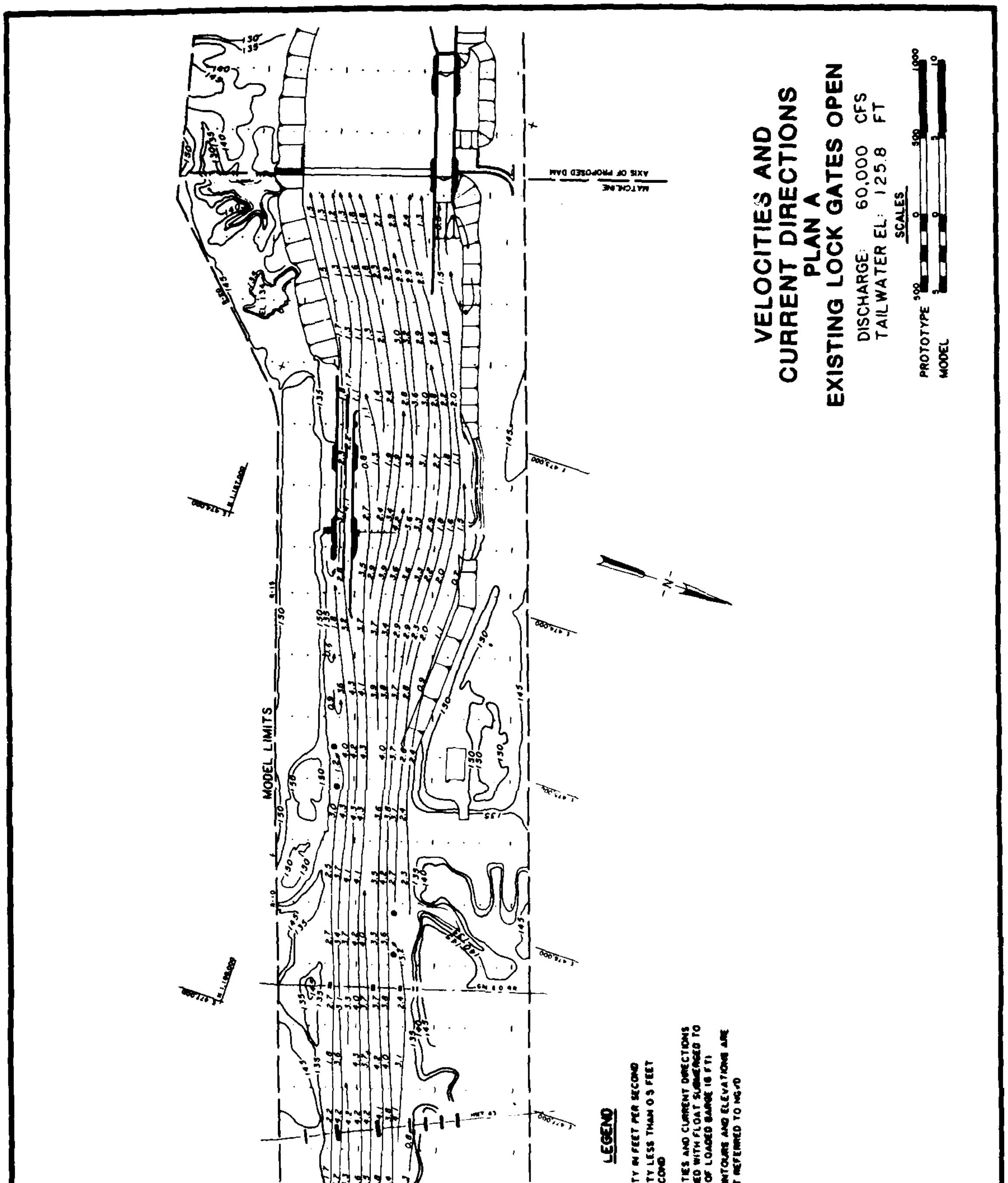
2.2 VELOCITY IN FEET PER SECOND

VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)

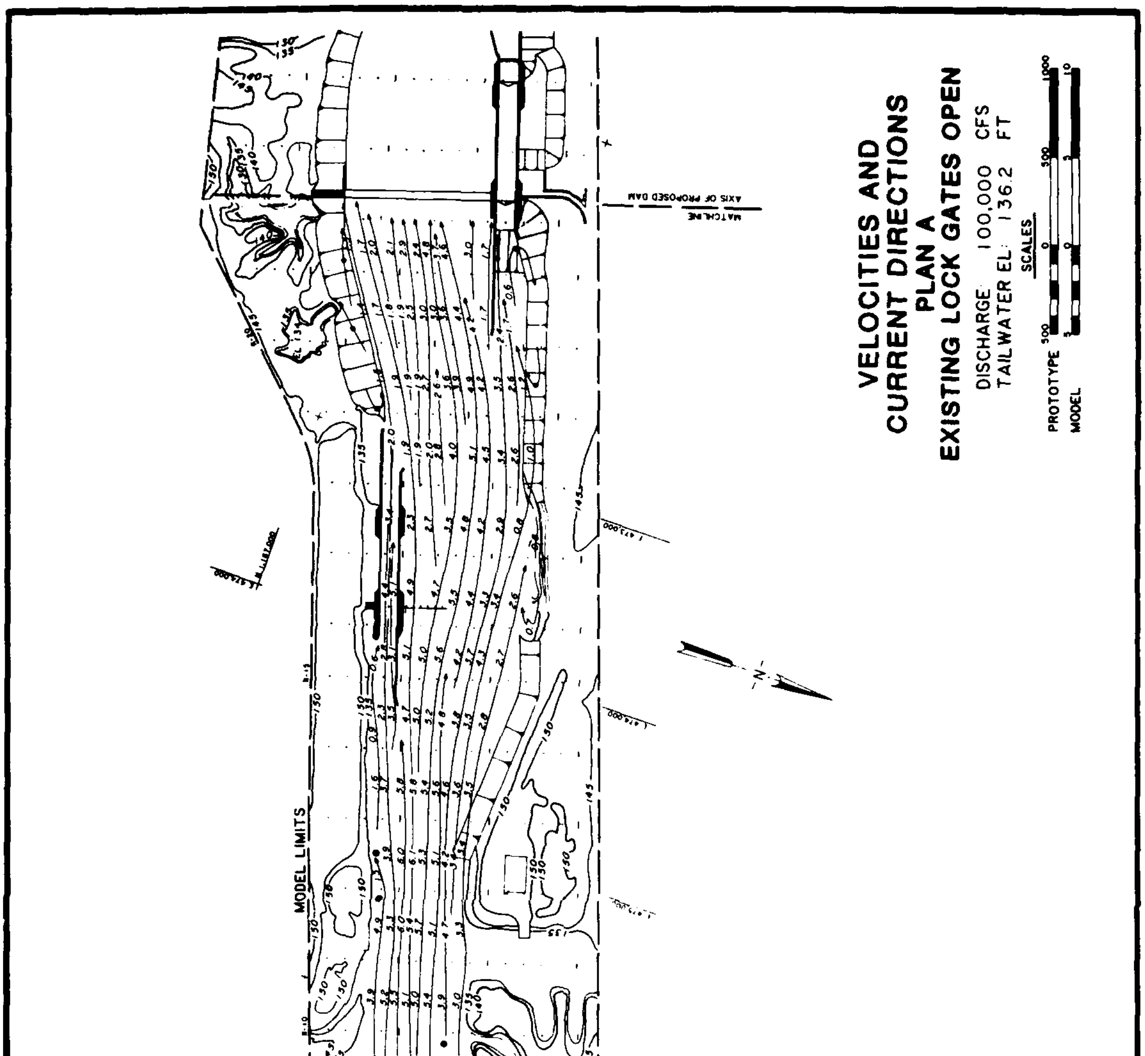
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD


VELOCITIES AND
CURRENT DIRECTIONS
PLAN A
EXISTING LOCK GATES OPEN
DISCHARGE: 30,000 CFS
TAILWATER EL: 113.8 FT
SCALES
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
FLOW
N
AXIS OF PROPOSED DAM
MATCHLINE



VELOCITIES AND
CURRENT DIRECTIONS
PLAN A
EXISTING LOCK GATES OPEN
DISCHARGE: 60,000 CFS
TAILWATER EL: 125.8 FT
SCALES
PROTOTYPE
MODEL
MODEL LIMITS
AXIS OF PROPOSED DAM
MATCHLINE
FLOW
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.3 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

PLATE 12


VELOCITIES AND
CURRENT DIRECTIONS
PLAN A
EXISTING LOCK GATES OPEN
DISCHARGE 100,000 CFS
TAILWATER EL 136.2 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
FLOW
AXIS OF PROPOSED DAM
MATCHLINE

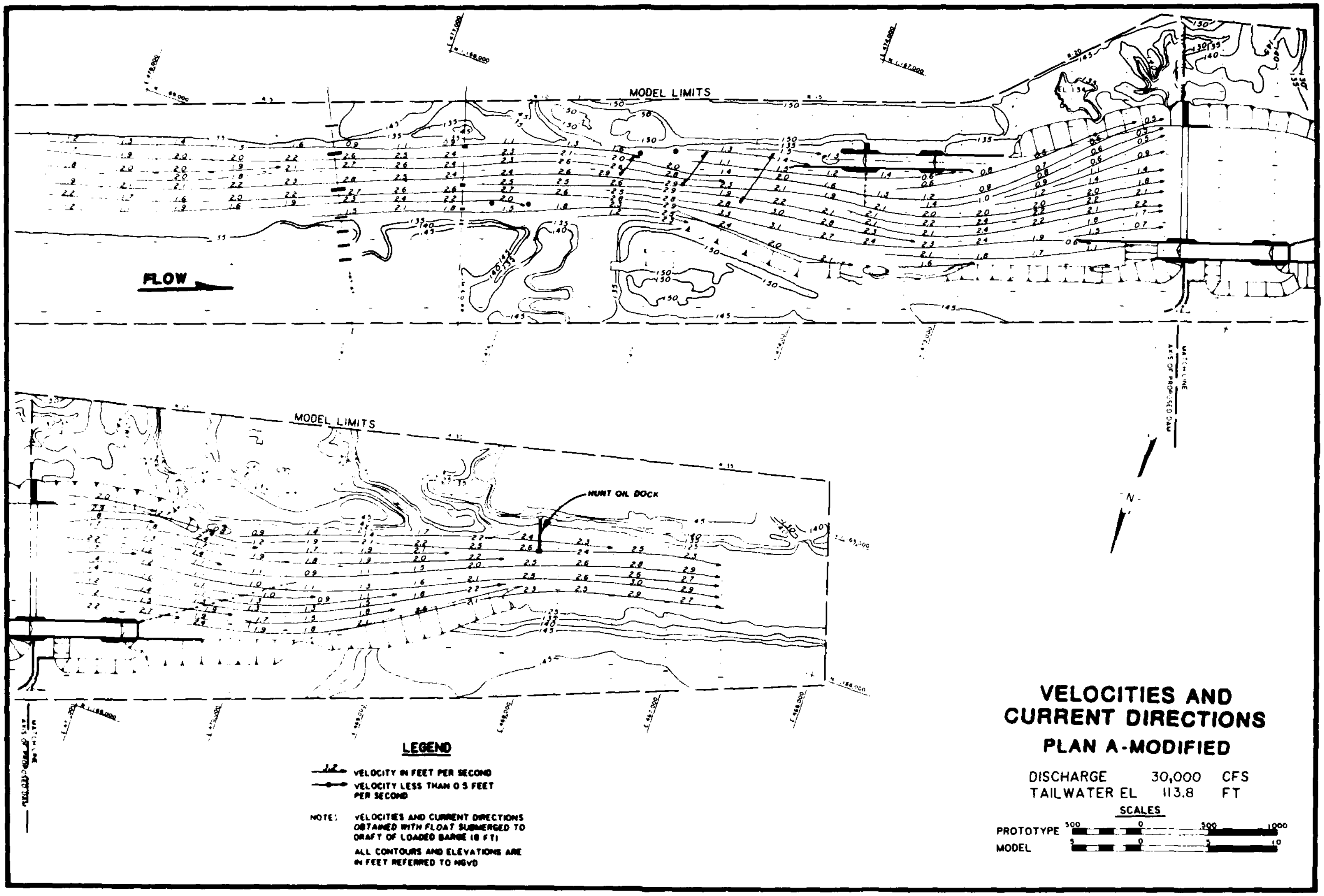
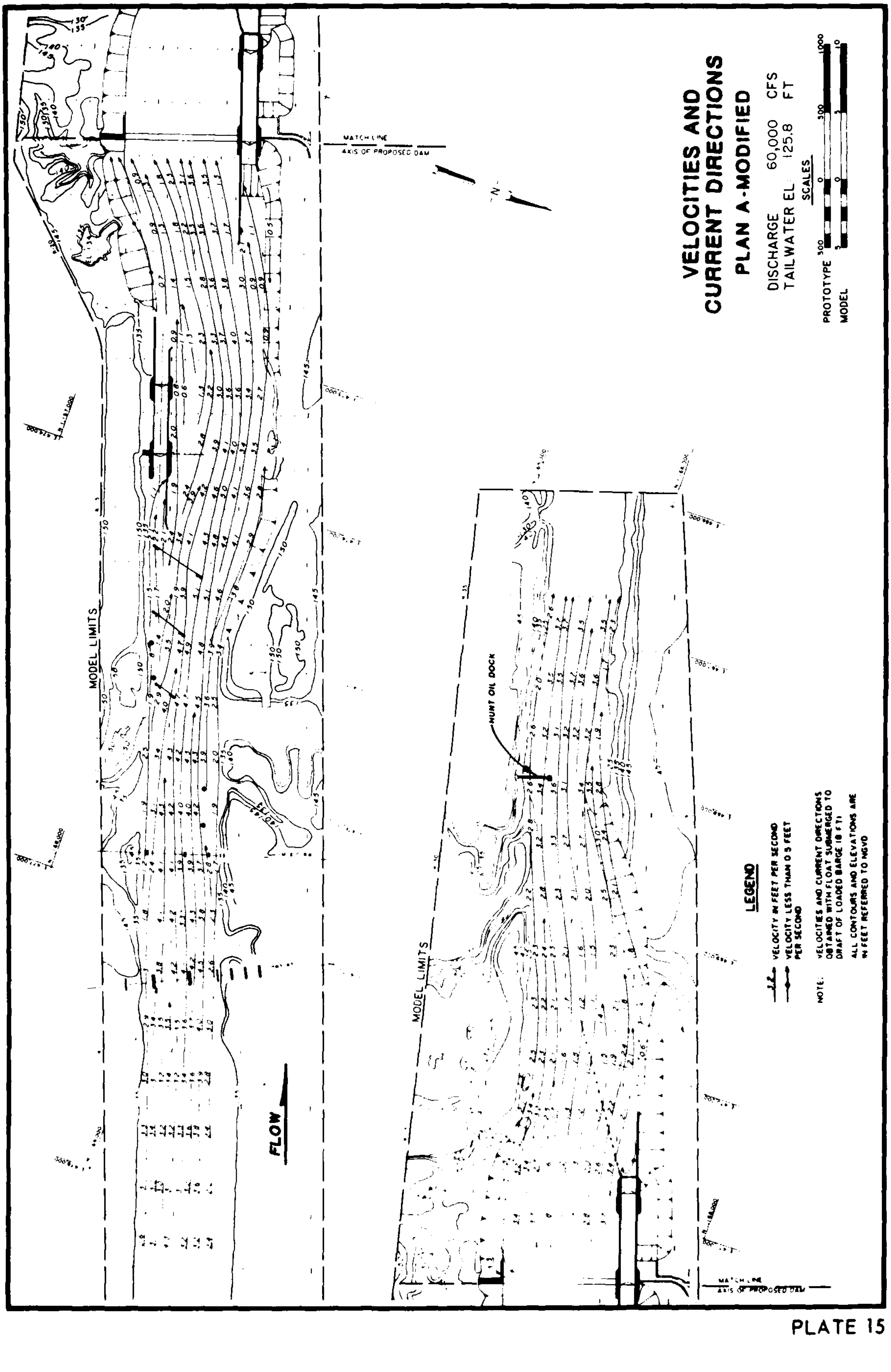
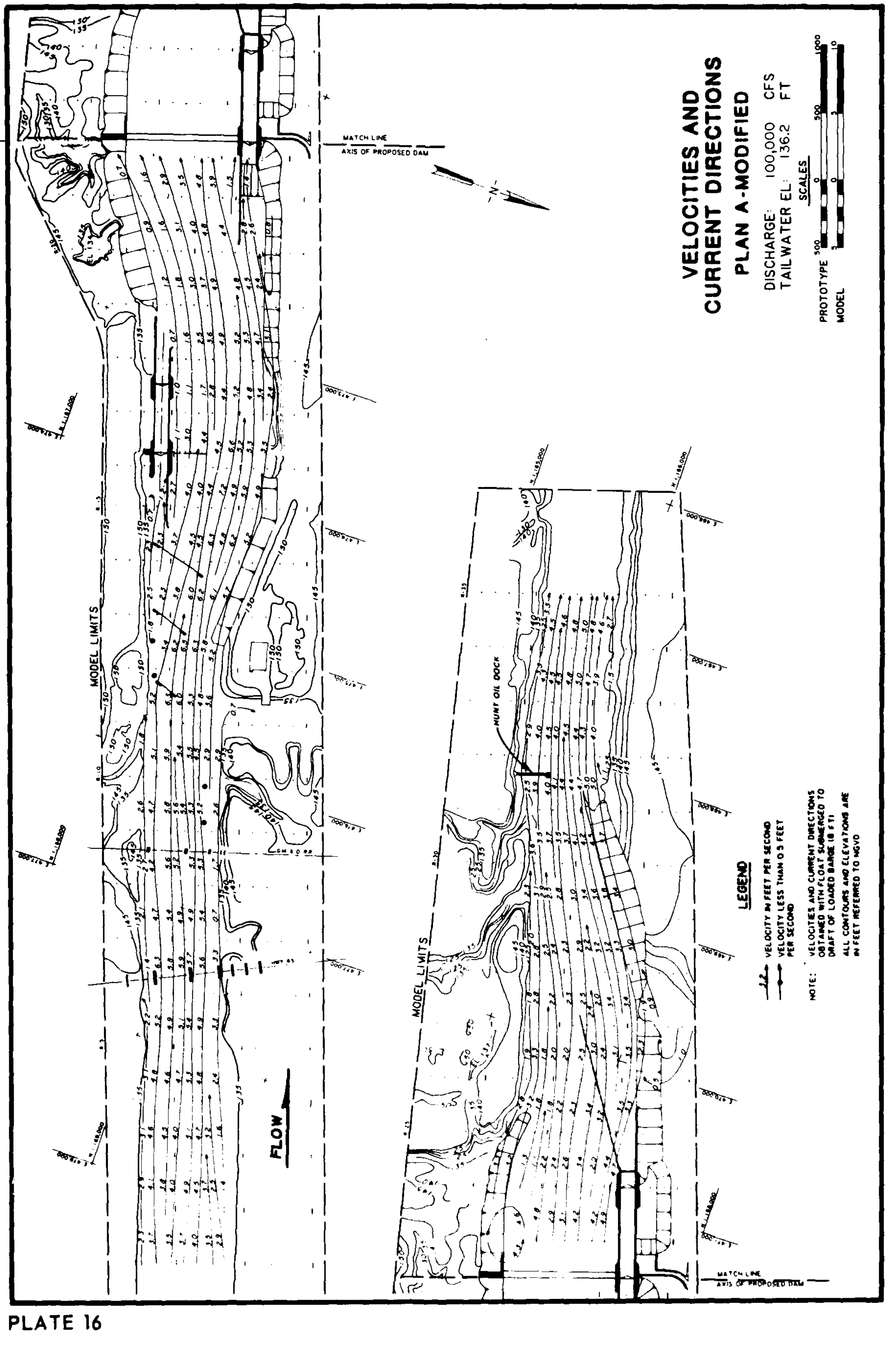

VELOCITIES AND CURRENT DIRECTIONS
PLAN A-MODIFIED
DISCHARGE 30,000 CFS
TAILWATER EL 113.8 FT
SCALES
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
FLOW
HUNT OIL DOCK
MATCH LINE
AXIS OF PROPOSED DAM
N

PLATE 14

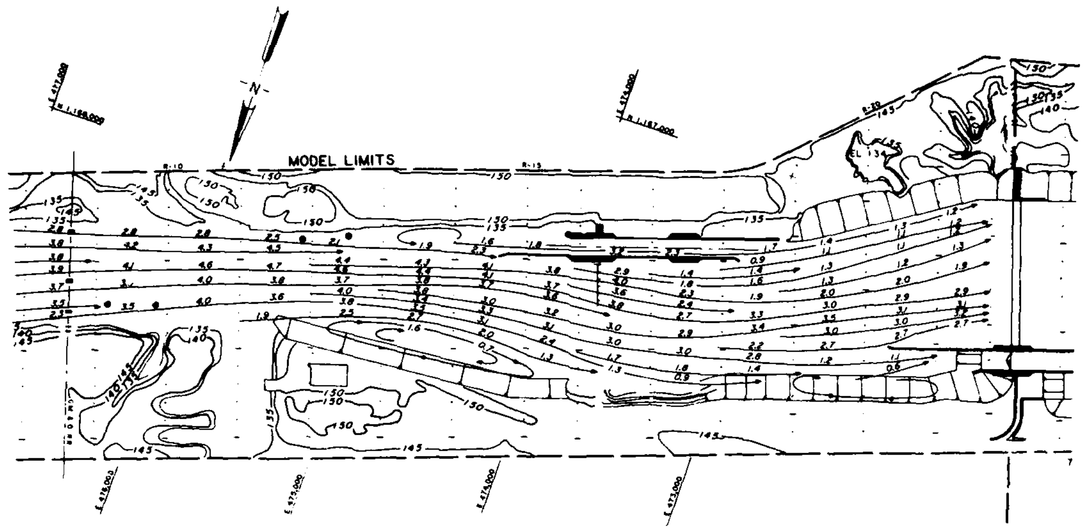


VELOCITIES AND CURRENT DIRECTIONS
PLAN A-MODIFIED
DISCHARGE 60,000 CFS
TAILWATER EL 125.8 FT
SCALES
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
MODEL LIMITS
MATCH LINE
AXIS OF PROPOSED DAM
MATCH LINE
AXIS OF PROPOSED DAM
HUNT OIL DOCK
FLOW
N

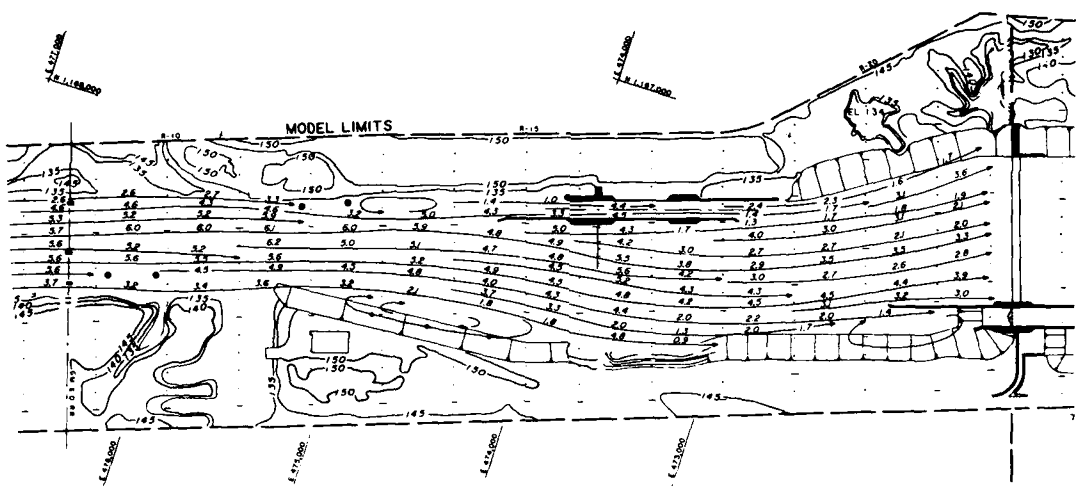


VELOCITIES AND CURRENT DIRECTIONS
PLAN A-MODIFIED
DISCHARGE: 100,000 CFS
TAILWATER EL. 136.2 FT
SCALES
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
FLOW
HUNT OIL DOCK
MATCH LINE
AXIS OF PROPOSED DAM

PLATE 16



DISCHARGE: 60,000 CFS
TAILWATER EL: 125.8 FT



DISCHARGE: 100,000 CFS
TAILWATER EL: 136.2 FT

LEGEND

3.2 VELOCITY IN FEET PER SECOND

VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)

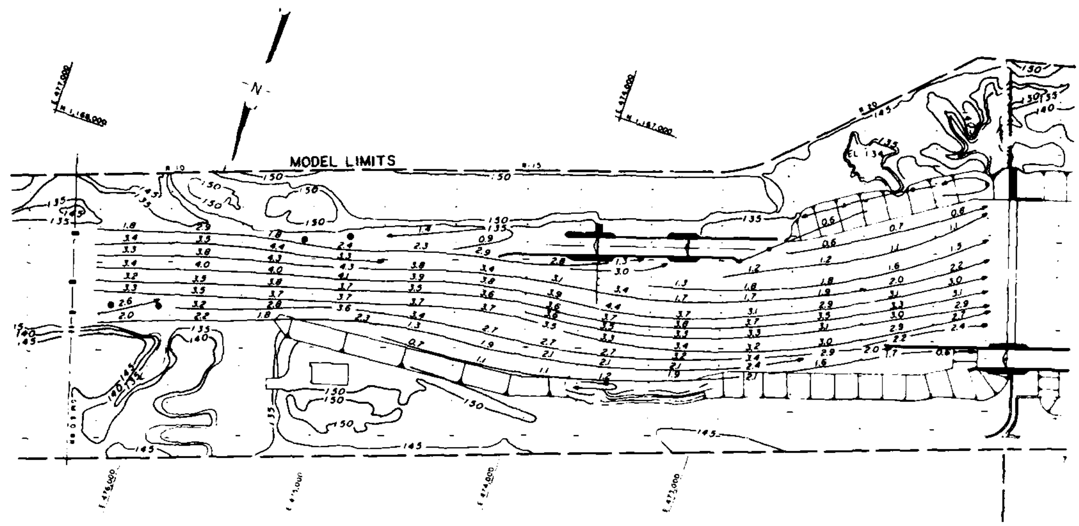
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS
PLAN B
EXISTING LOCK GATES OPEN

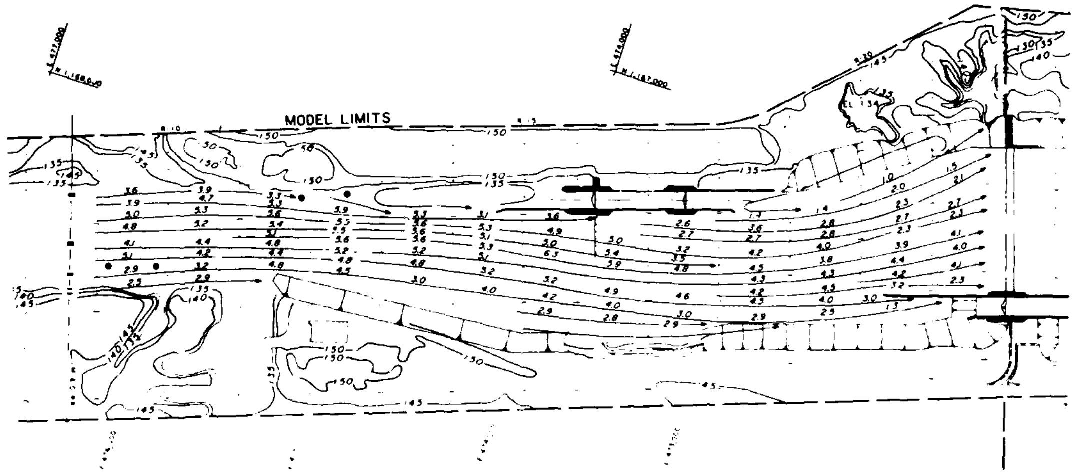
SCALES

PROTOTYPE 500 0 500 1000

MODEL 5 0 5 10



DISCHARGE: 60,000 CFS
TAILWATER EL: 125.8 FT



DISCHARGE: 100,000 CFS
TAILWATER EL: 136.2 FT

LEGEND

VELOCITY IN FEET PER SECOND

VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS PLAN B EXISTING LOCK GATES CLOSED

SCALES

PROTOTYPE 500 0 500 1000

MODEL 5 0 5 10

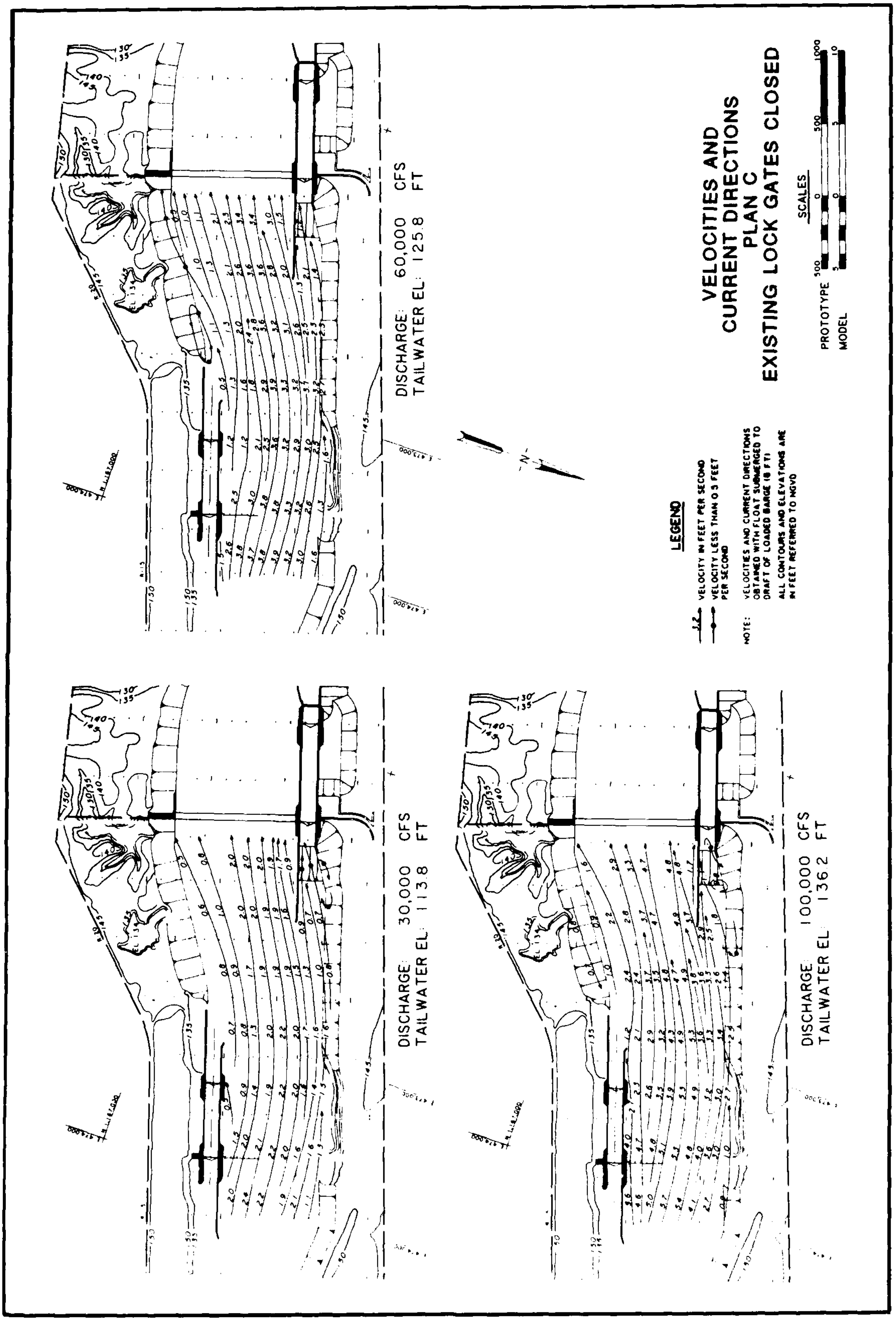
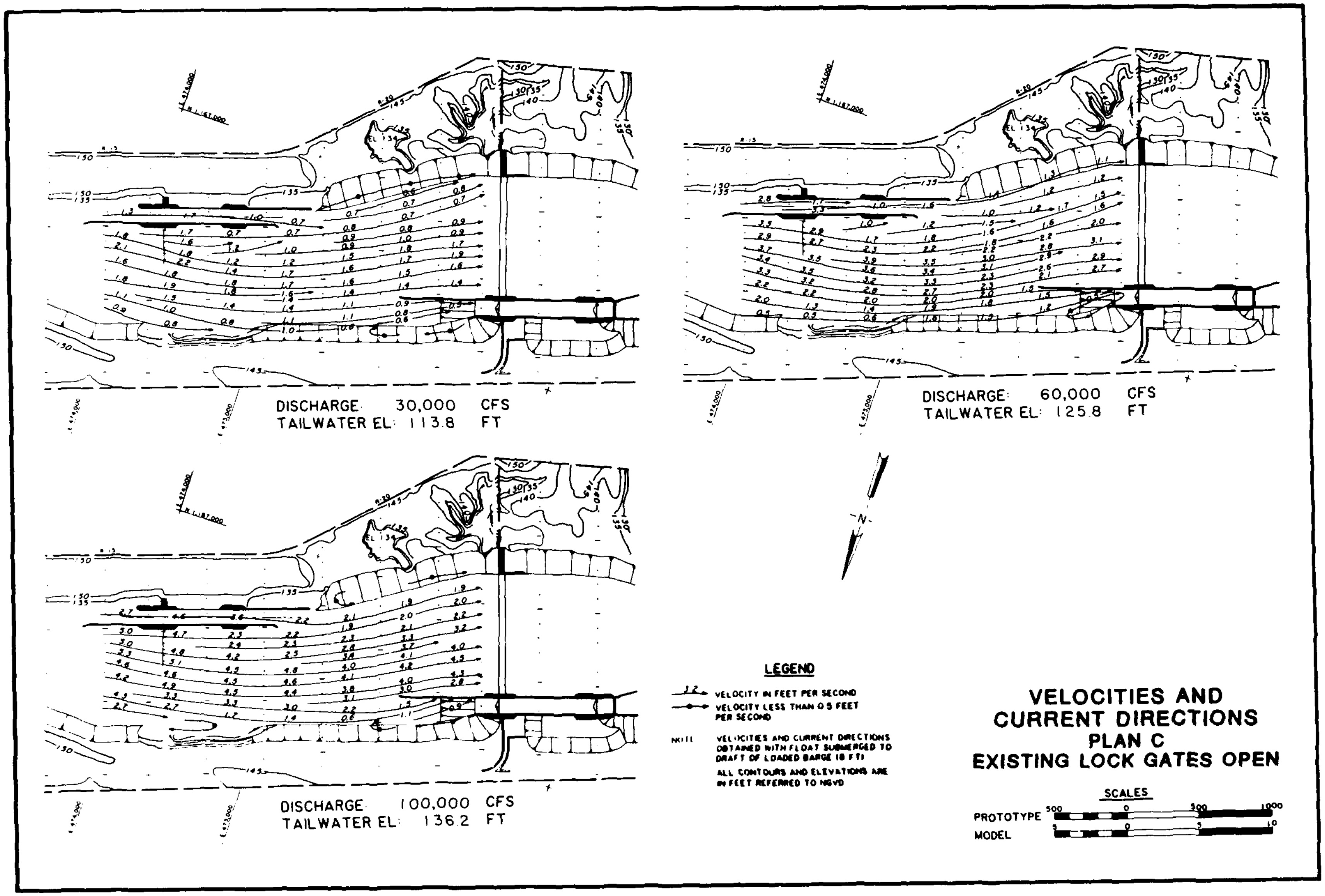
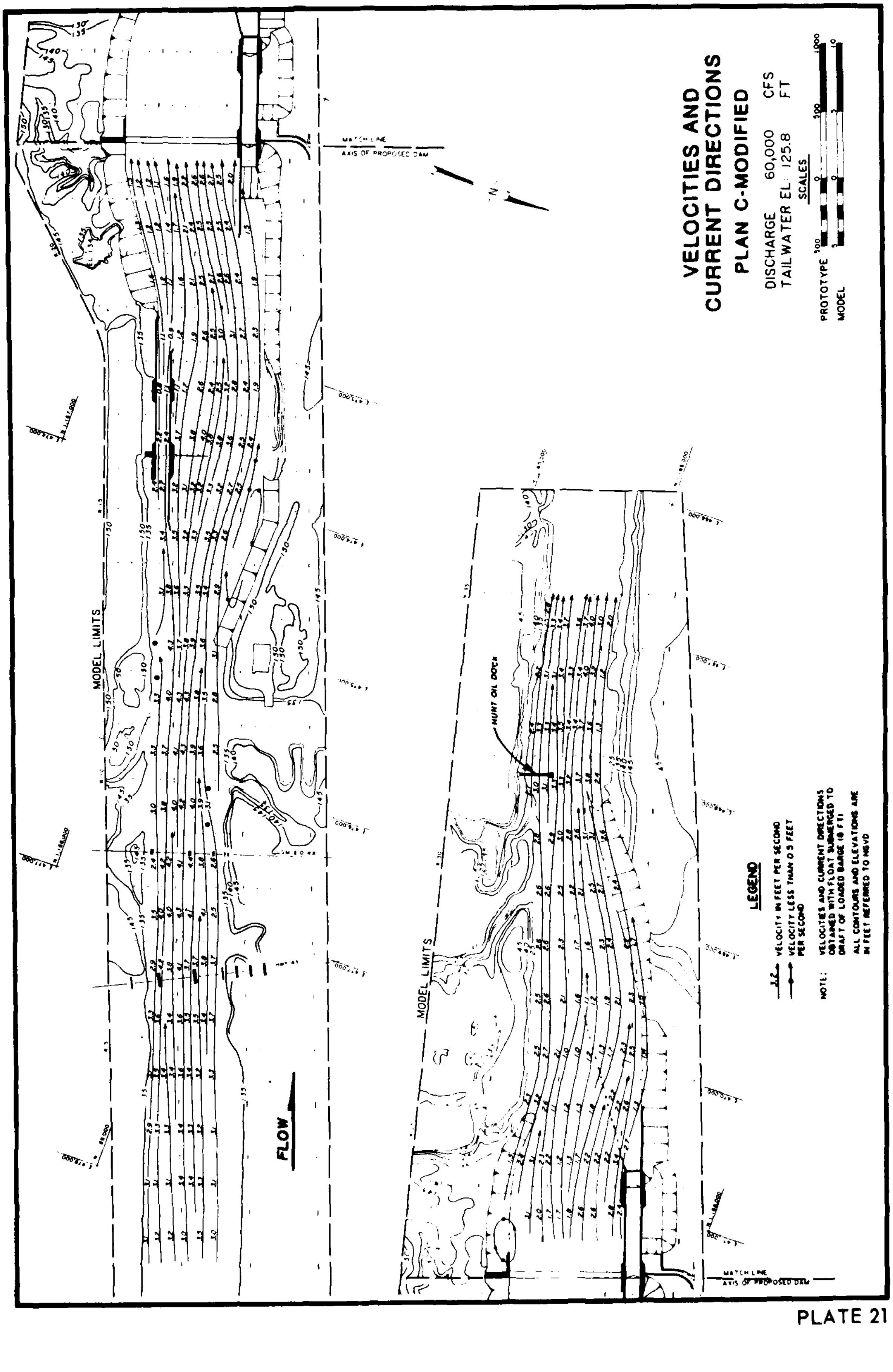

VELOCITIES AND
CURRENT DIRECTIONS
PLAN C
EXISTING LOCK GATES CLOSED
SCALES
PROTOTYPE
MODEL
DISCHARGE: 60,000 CFS
TAILWATER EL: 125.8 FT
DISCHARGE: 30,000 CFS
TAILWATER EL: 113.8 FT
DISCHARGE: 100,000 CFS
TAILWATER EL: 136.2 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

PLATE 19


DISCHARGE: 30,000 CFS
TAILWATER EL: 113.8 FT
DISCHARGE: 60,000 CFS
TAILWATER EL: 125.8 FT
DISCHARGE: 100,000 CFS
TAILWATER EL: 136.2 FT
N
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
VELOCITIES AND CURRENT DIRECTIONS
PLAN C
EXISTING LOCK GATES OPEN
SCALES
PROTOTYPE
MODEL


VELOCITIES AND CURRENT DIRECTIONS
PLAN C-MODIFIED
DISCHARGE 60,000 CFS
TAILWATER EL 125.8 FT
SCALES
PROTOTYPE
MODEL
MODEL LIMITS
FLOW
MATCH LINE
AXIS OF PROPOSED DAM
HUNT OIL DOCK
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

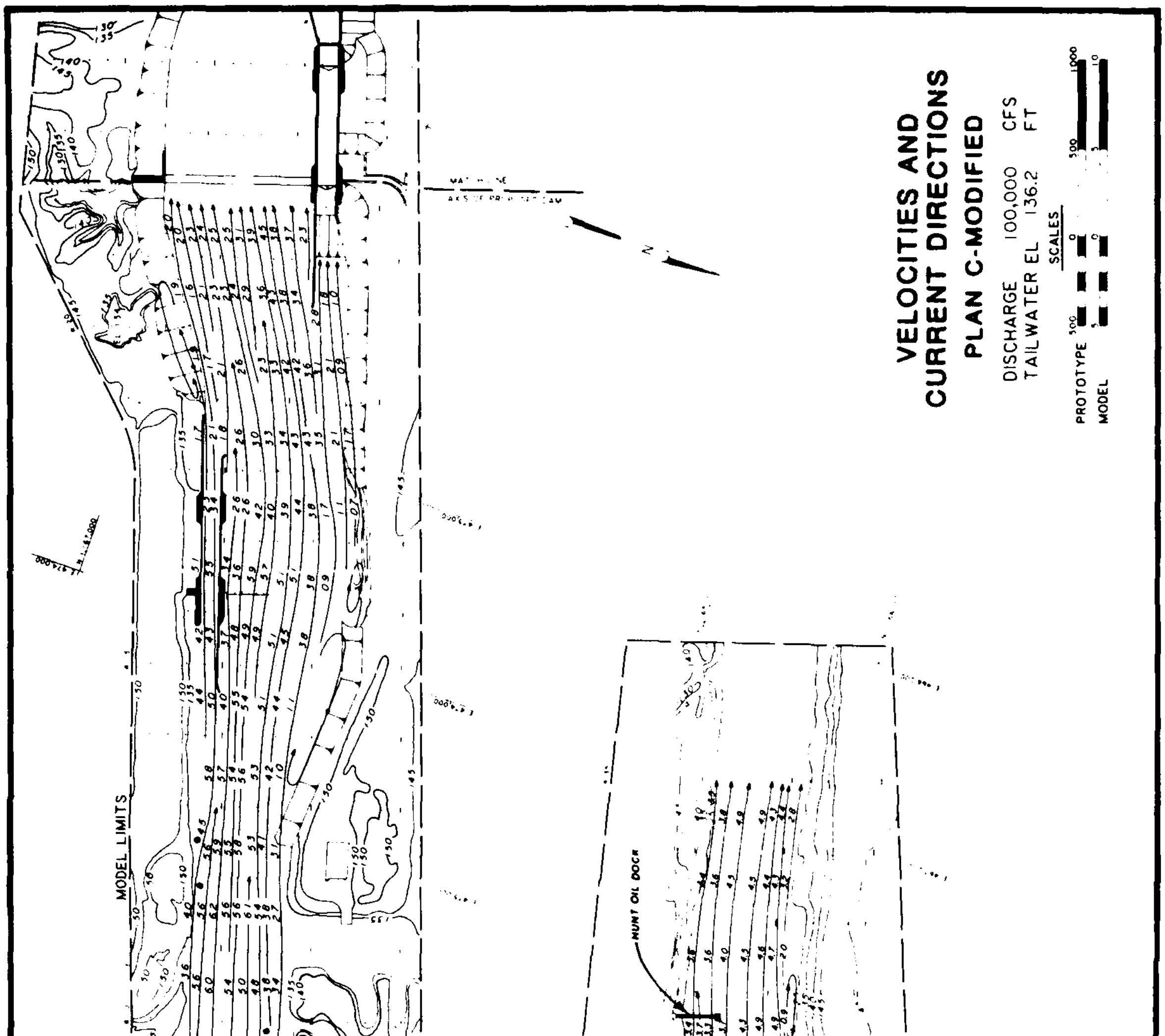

VELOCITIES AND
CURRENT DIRECTIONS
PLAN C-MODIFIED
DISCHARGE 100,000 CFS
TAILWATER EL 136.2 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
HUNT OIL DOCK
FLOW
N

PLATE 22

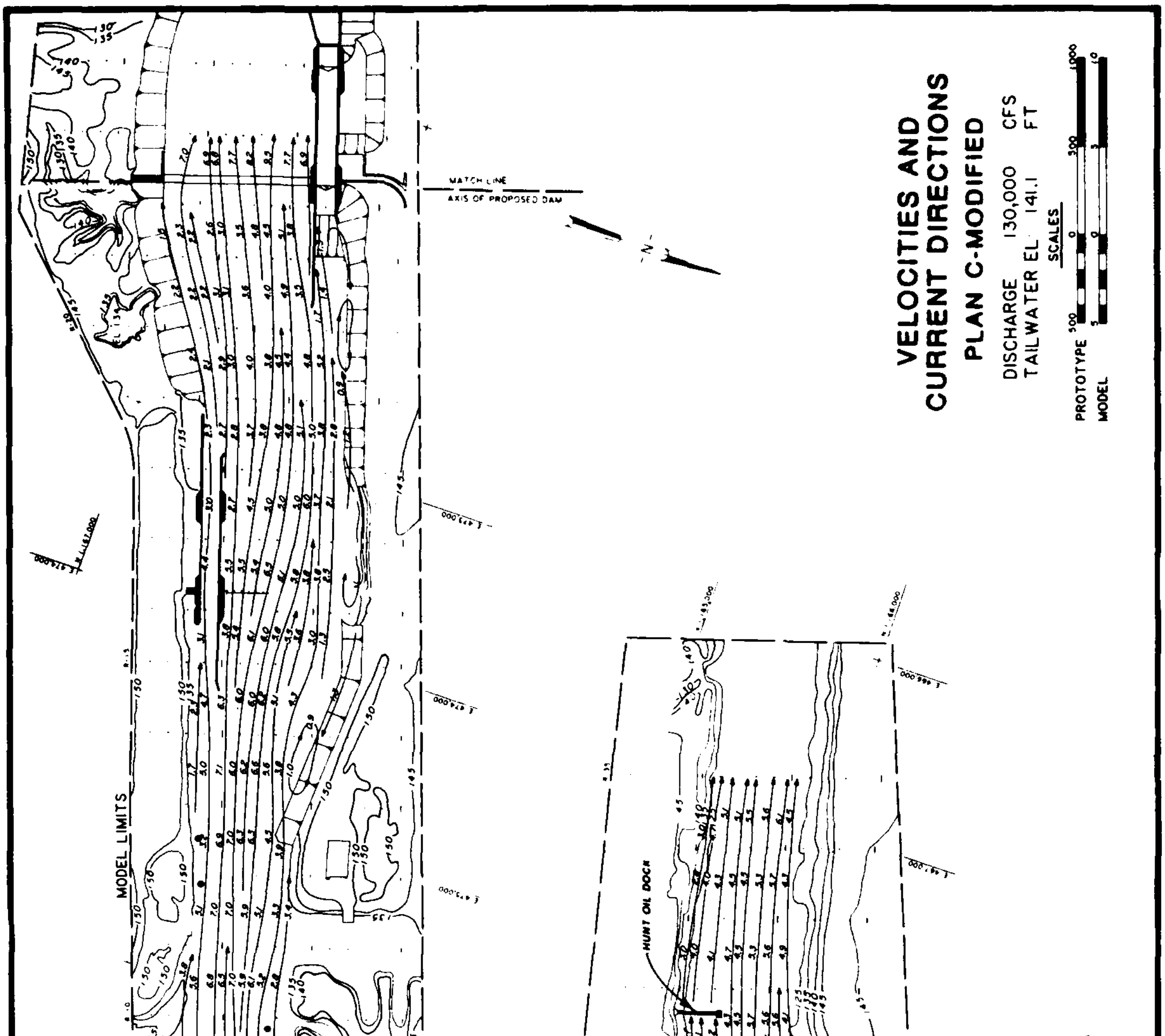
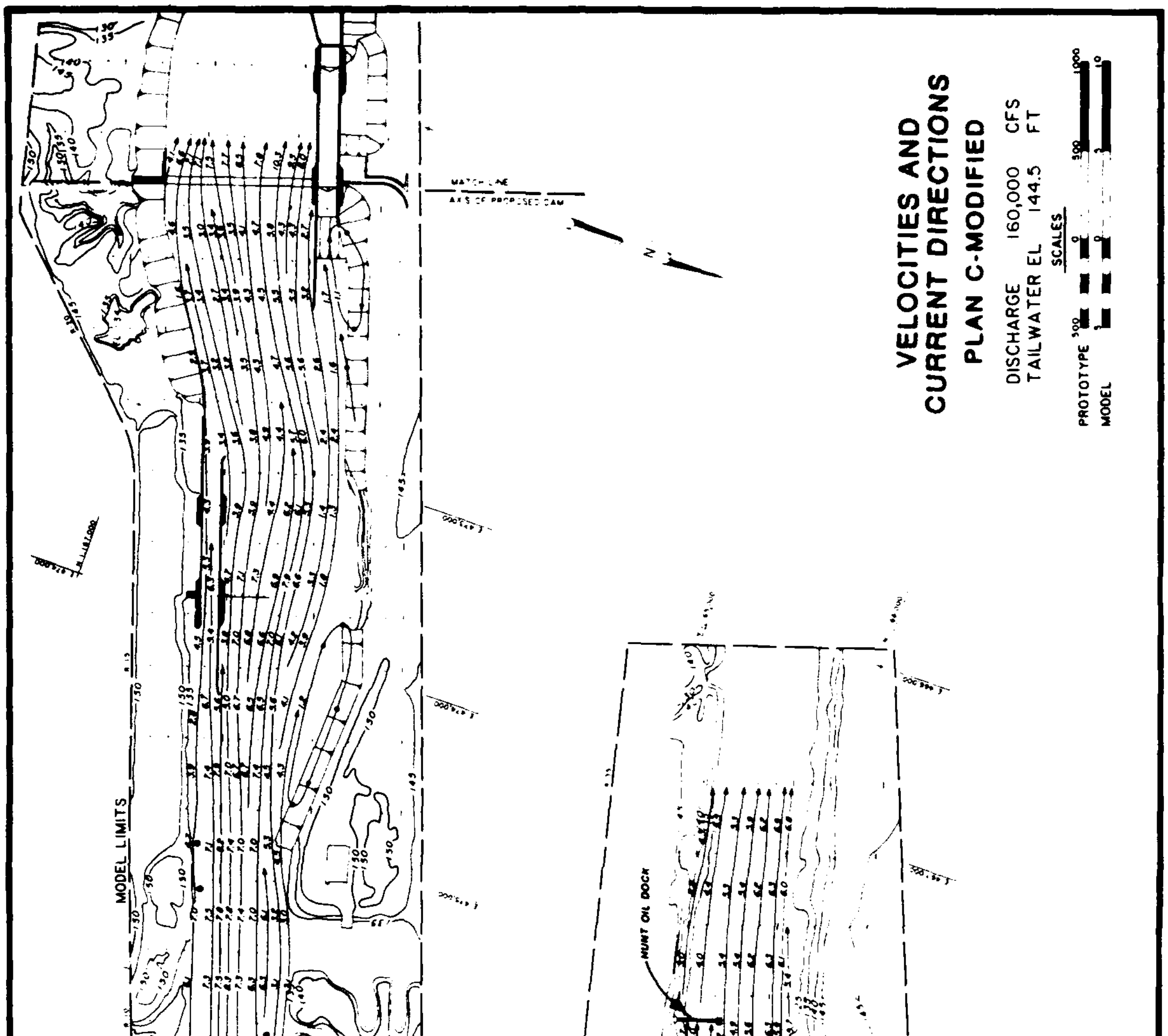
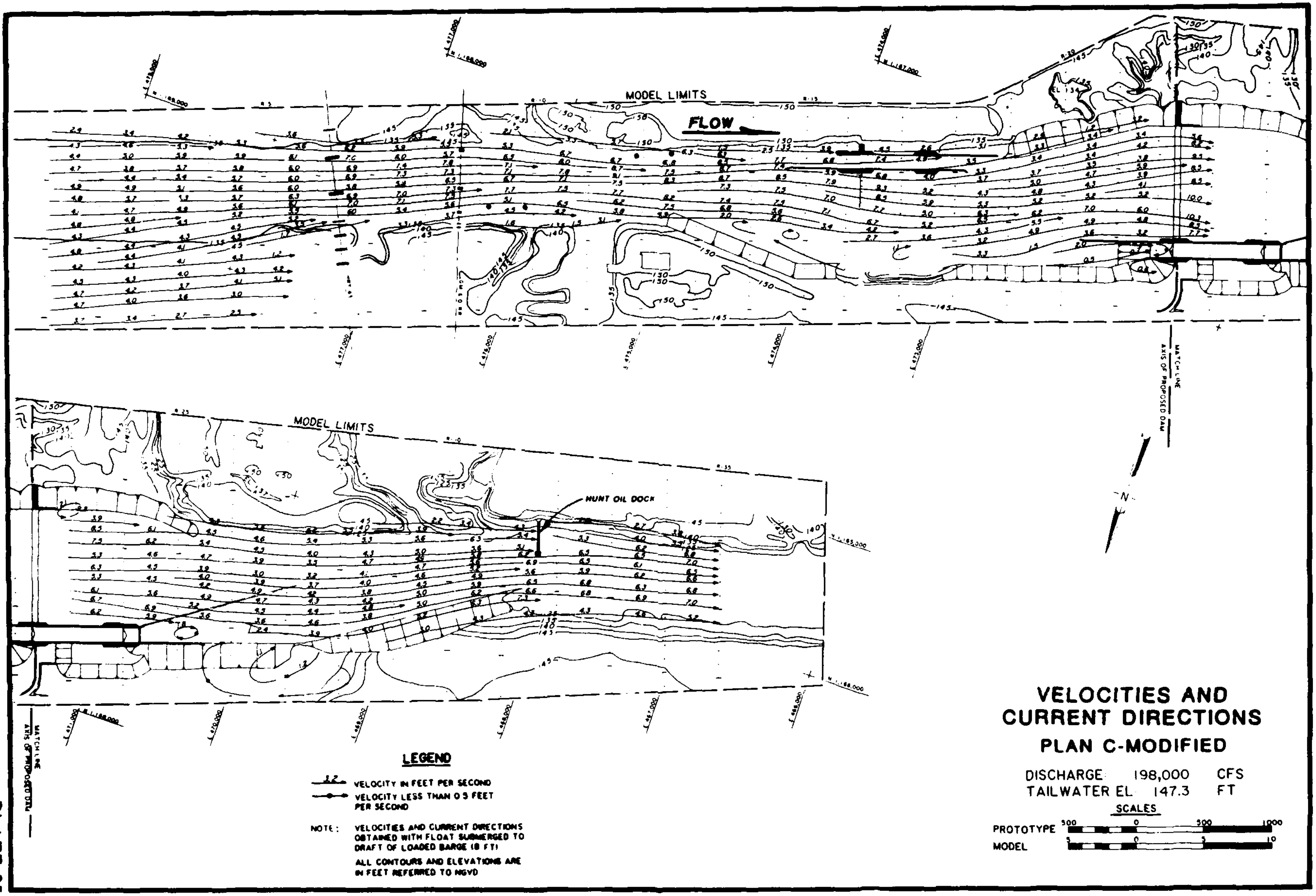

VELOCITIES AND
CURRENT DIRECTIONS
PLAN C-MODIFIED
DISCHARGE 130,000 CFS
TAILWATER EL 141.1 FT
SCALES
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
FLOW
HUNT OIL DOCK
MATCH LINE
AXIS OF PROPOSED DAM

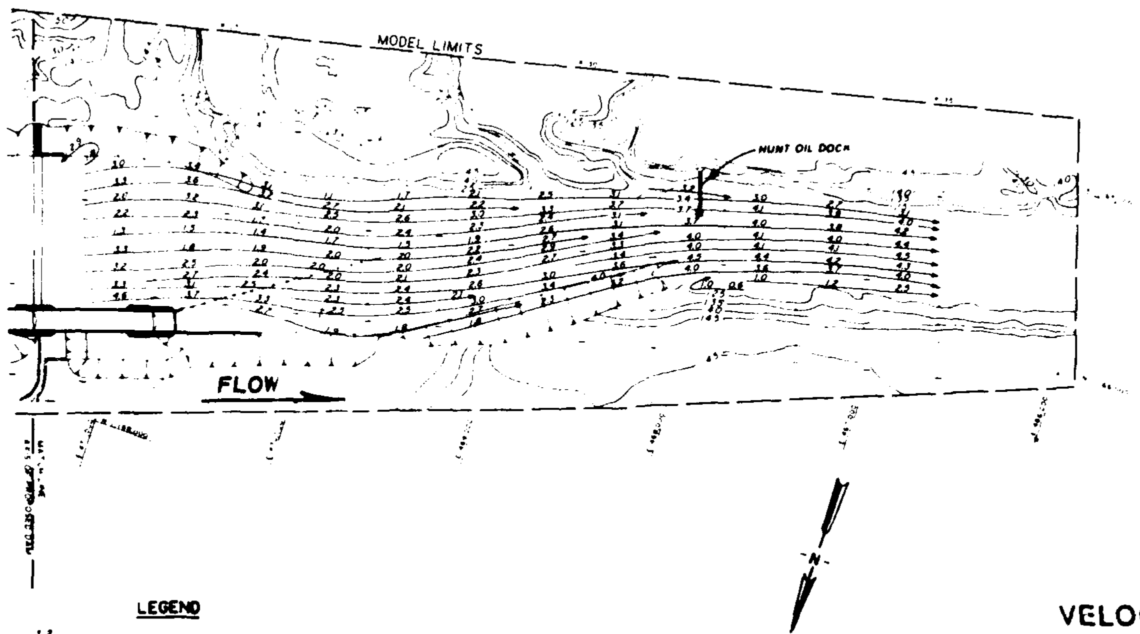
PLATE 23



VELOCITIES AND
CURRENT DIRECTIONS
PLAN C-MODIFIED
DISCHARGE 160,000 CFS
TAILWATER EL 144.5 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
FLOW
HUNT OIL DOCK
MATCH LINE
AXIS OF PROPOSED DAM

PLATE 24


MODEL LIMITS
FLOW
HUNT OIL DOCK
MATCH LINE
AXIS OF PROPOSED DAM
N
VELOCITIES AND
CURRENT DIRECTIONS
PLAN C-MODIFIED
DISCHARGE 198,000 CFS
TAILWATER EL 147.3 FT
SCALES
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD



LEGEND

VELOCITY IN FEET PER SECOND

VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)

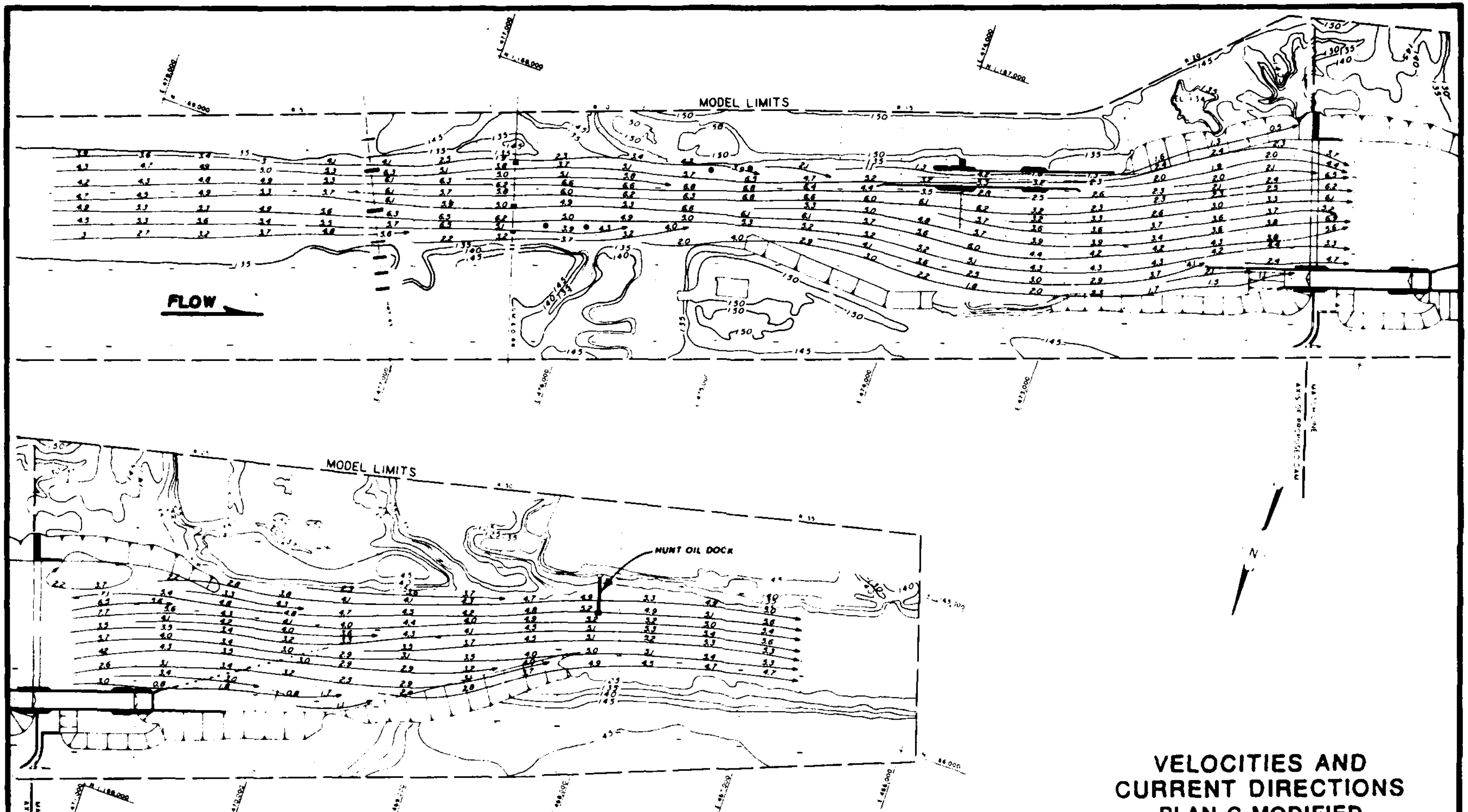
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS
PLAN C-MODIFIED
RISING TAILWATER

DISCHARGE 60,000 CFS
TAILWATER EL 120.6 FT

SCALES

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10



VELOCITIES AND CURRENT DIRECTIONS
PLAN C-MODIFIED
RISING TAILWATER

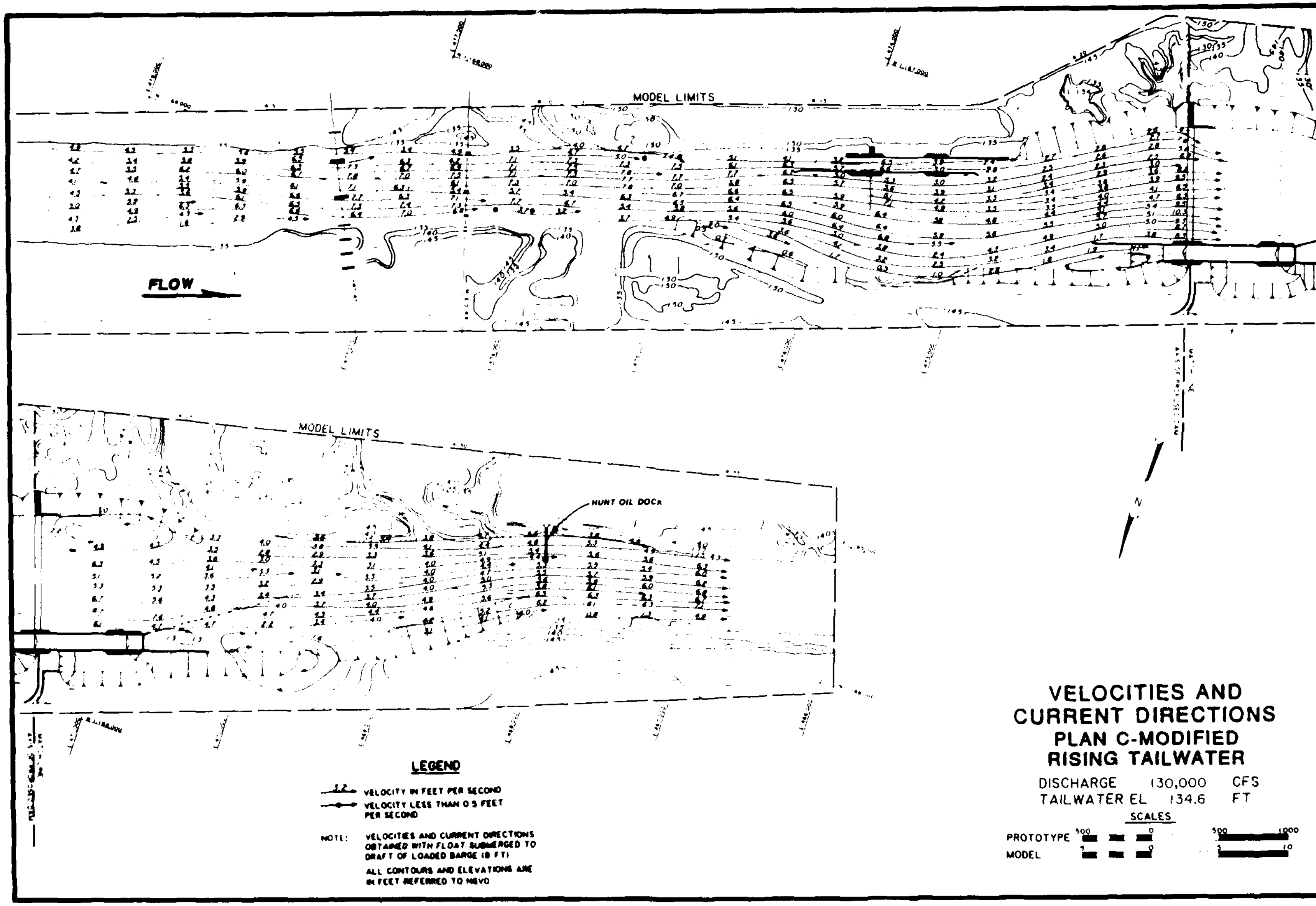
DISCHARGE 100,000 CFS
TAILWATER EL 129.9 FT

SCALES
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

LEGEND

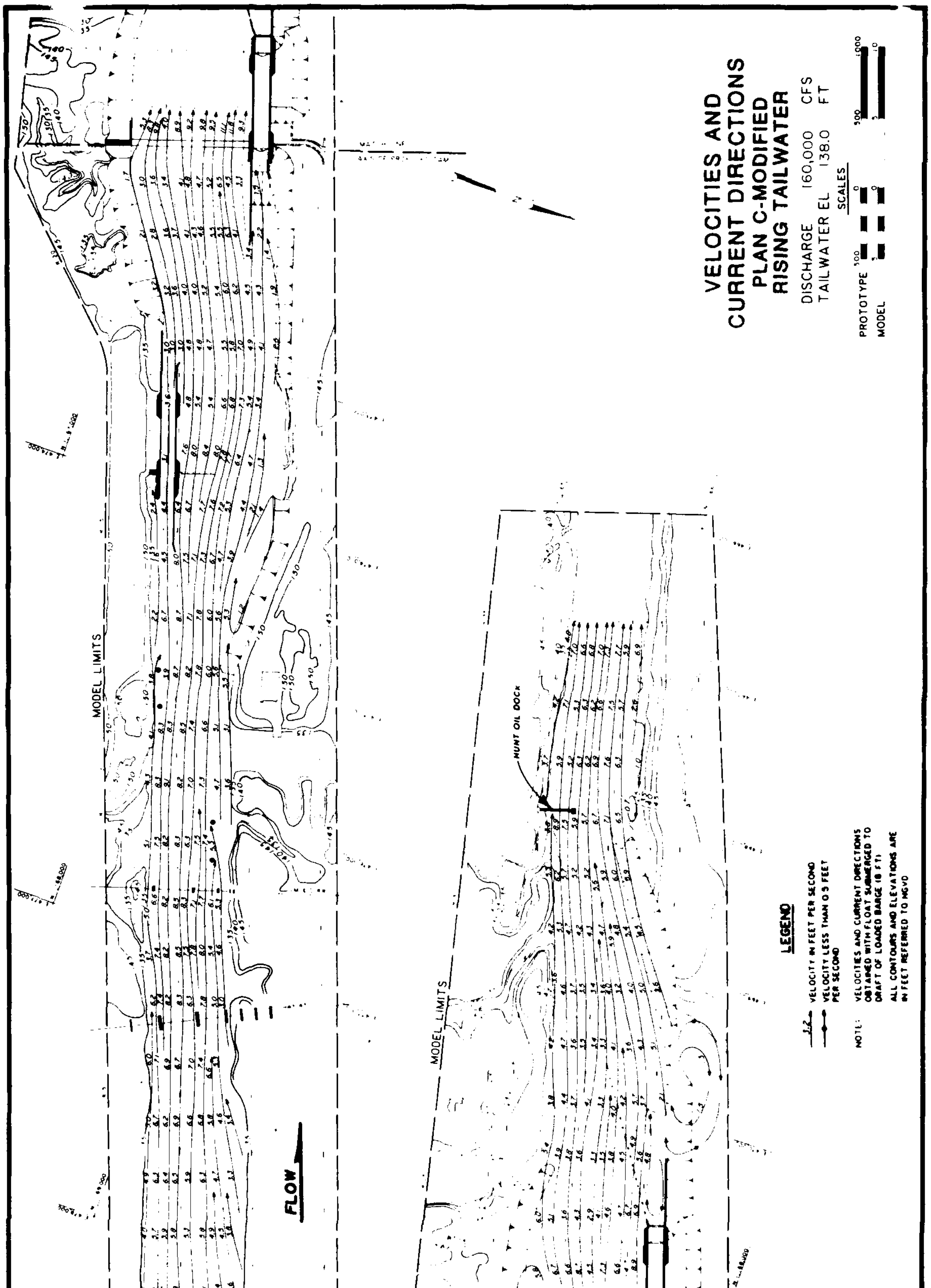
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD



VELOCITIES AND
CURRENT DIRECTIONS
PLAN C-MODIFIED
RISING TAILWATER
DISCHARGE 130,000 CFS
TAILWATER EL 134.6 FT
SCALES
PROTOTYPE
MODEL
MODEL LIMITS
FLOW
HUNT OIL DOCK
N
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

PLATE 28



VELOCITIES AND
CURRENT DIRECTIONS
PLAN C-MODIFIED
RISING TAILWATER
DISCHARGE 160,000 CFS
TAILWATER EL 138.0 FT
SCALES
PROTOTYPE
MODEL
MODEL LIMITS
FLOW
HUNT OIL DOCK
MATCH LINE
AXIS OF PROPOSED DAM
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

PLATE 29

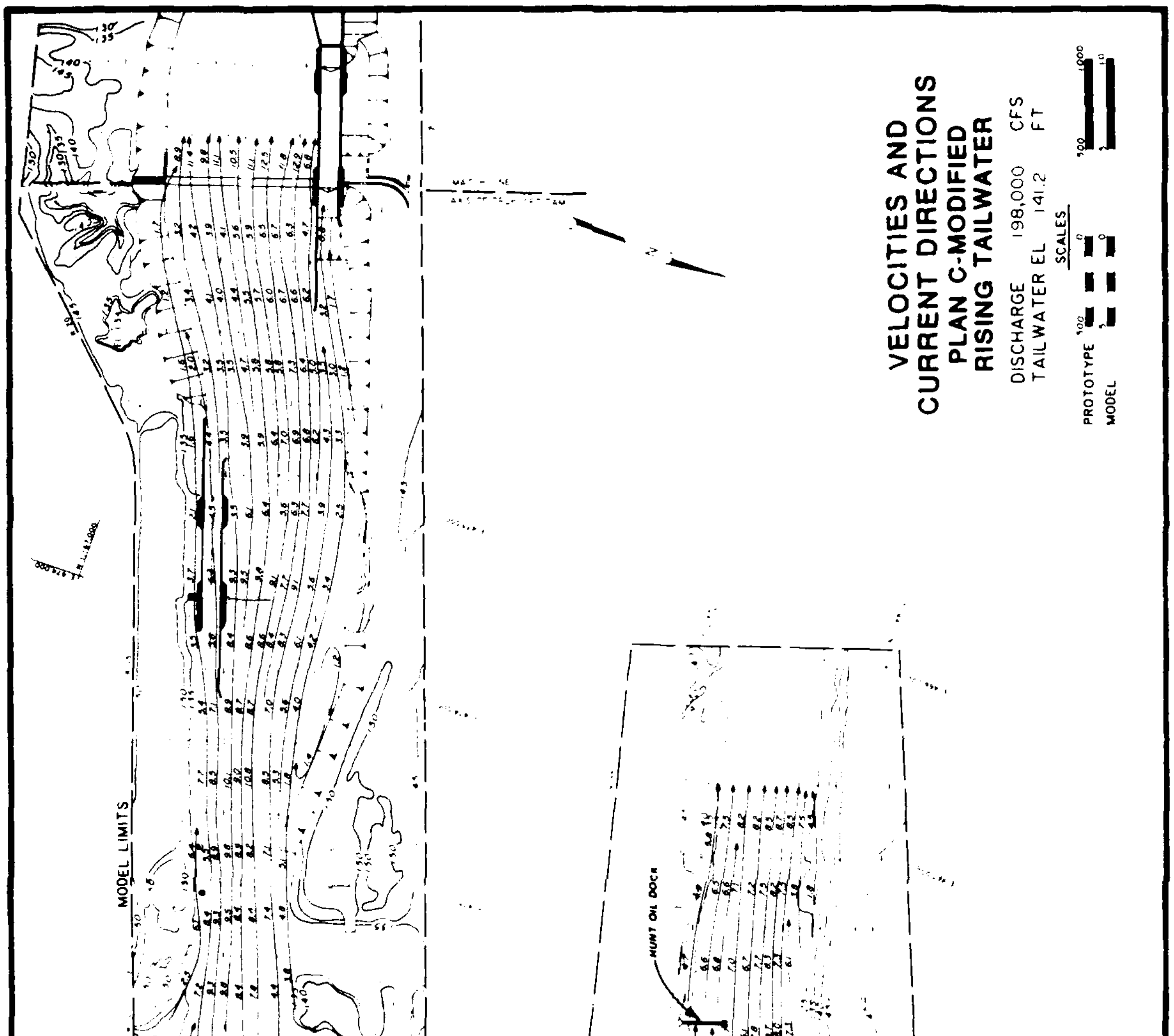
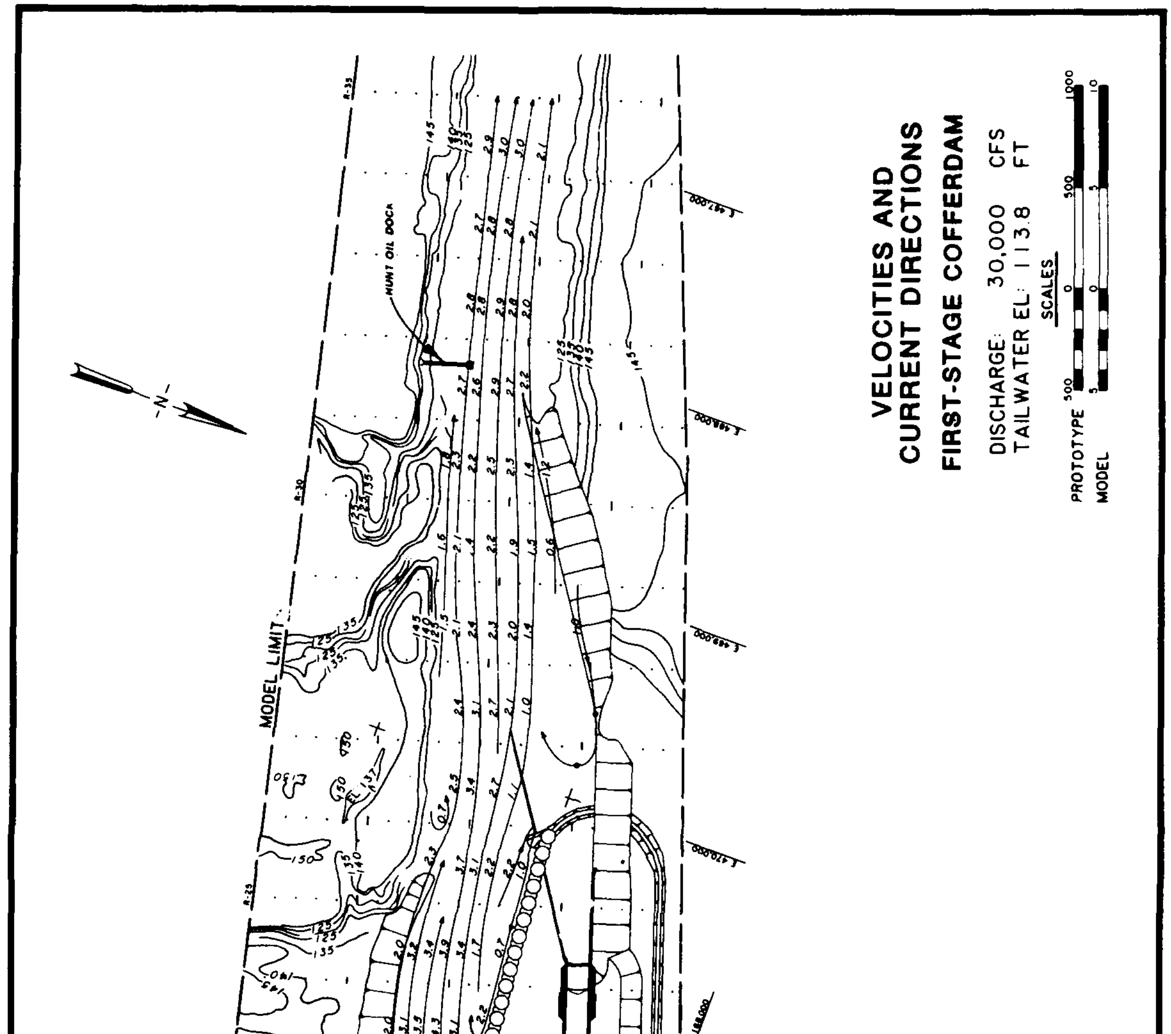

VELOCITIES AND
CURRENT DIRECTIONS
PLAN C-MODIFIED
RISING TAILWATER
DISCHARGE 198,000 CFS
TAILWATER EL 141.2 FT
SCALES
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10
LEGEND
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
FLOW
HUNT OIL DOCK
MODEL LIMITS

PLATE 30



VELOCITIES AND CURRENT DIRECTIONS
FIRST-STAGE COFFERDAM
DISCHARGE: 30,000 CFS
TAILWATER EL: 113.8 FT

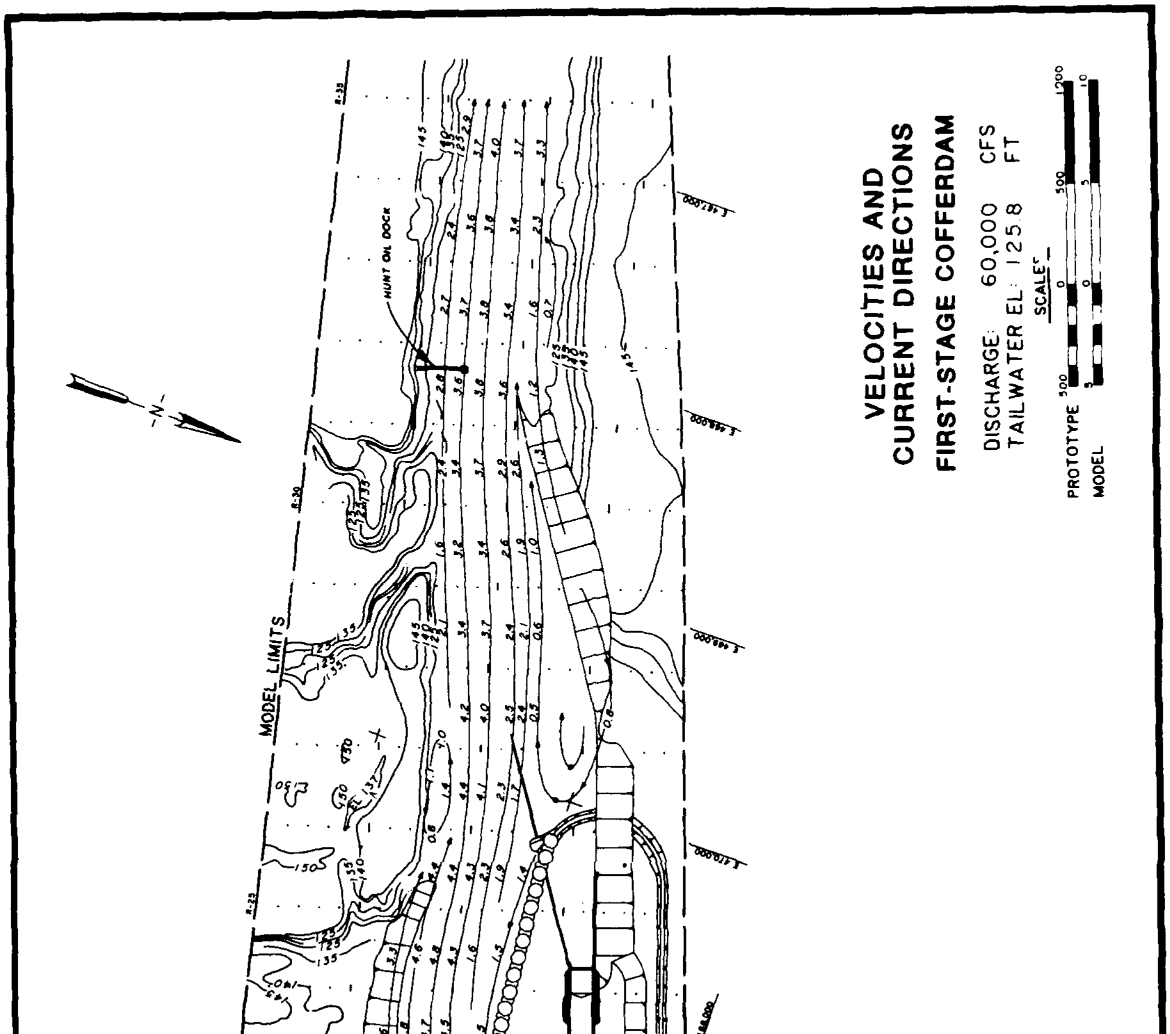
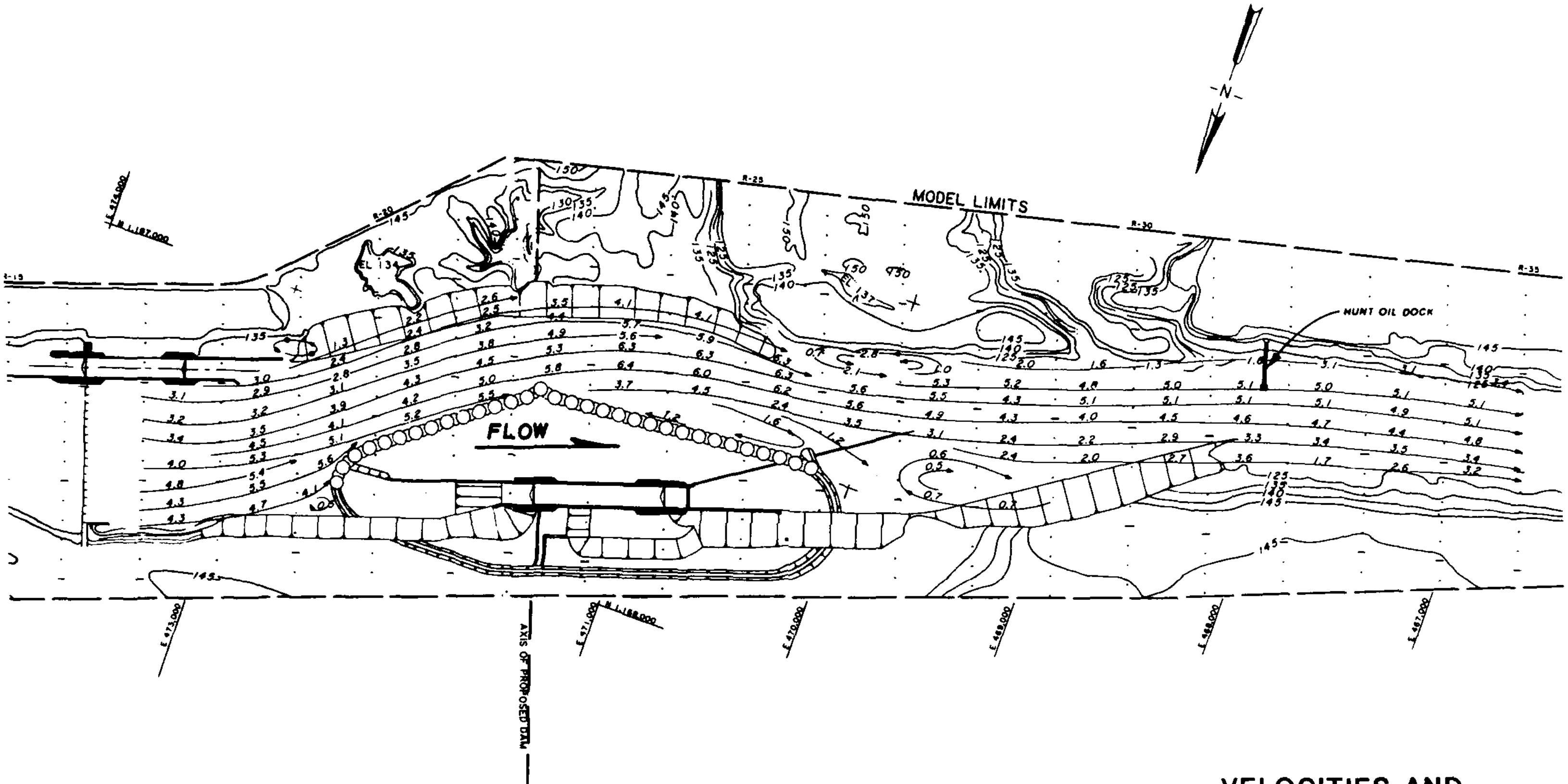

VELOCITIES AND
CURRENT DIRECTIONS
FIRST-STAGE COFFERDAM
DISCHARGE: 60,000 CFS
TAILWATER EL: 125.8 FT
SCALE
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
HUNT OIL DOCK
FLOW
AXIS OF PROPOSED DAM

PLATE 32



LEGEND

3.2 — VELOCITY IN FEET PER SECOND

—•— VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

FIRST-STAGE COFFERDAM

DISCHARGE: 100,000 CFS

TAILWATER EL: 136.2 FT

SCALES

PROTOTYPE 500 0 500 1000

MODEL 5 0 5 10

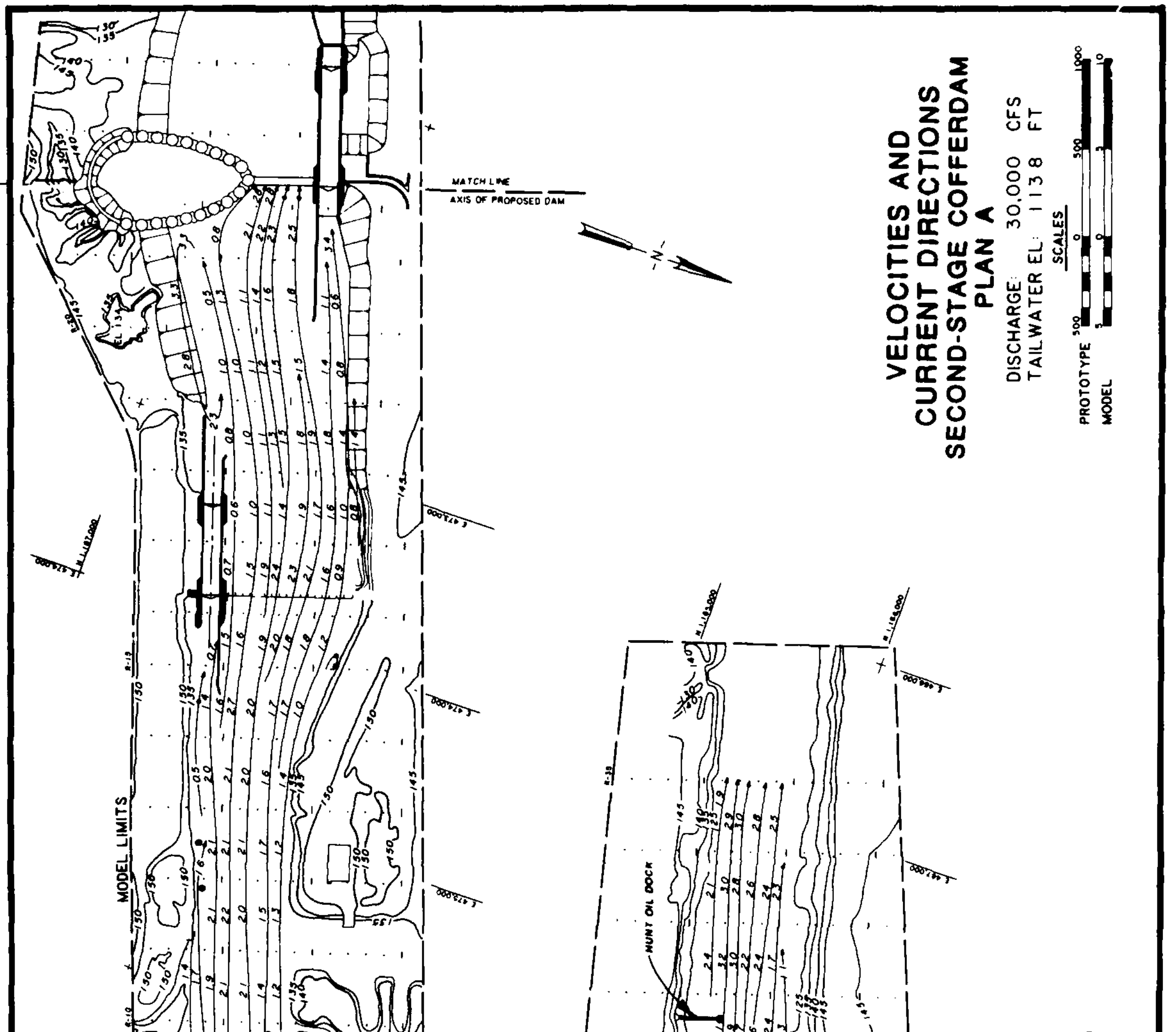

VELOCITIES AND CURRENT DIRECTIONS SECOND-STAGE COFFERDAM PLAN A
DISCHARGE: 30,000 CFS
TAILWATER EL: 1138 FT
SCALES
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10
MATCH LINE
AXIS OF PROPOSED DAM
MODEL LIMITS
FLOW
HUNT OIL DOCK
LEGEND
3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

PLATE 34

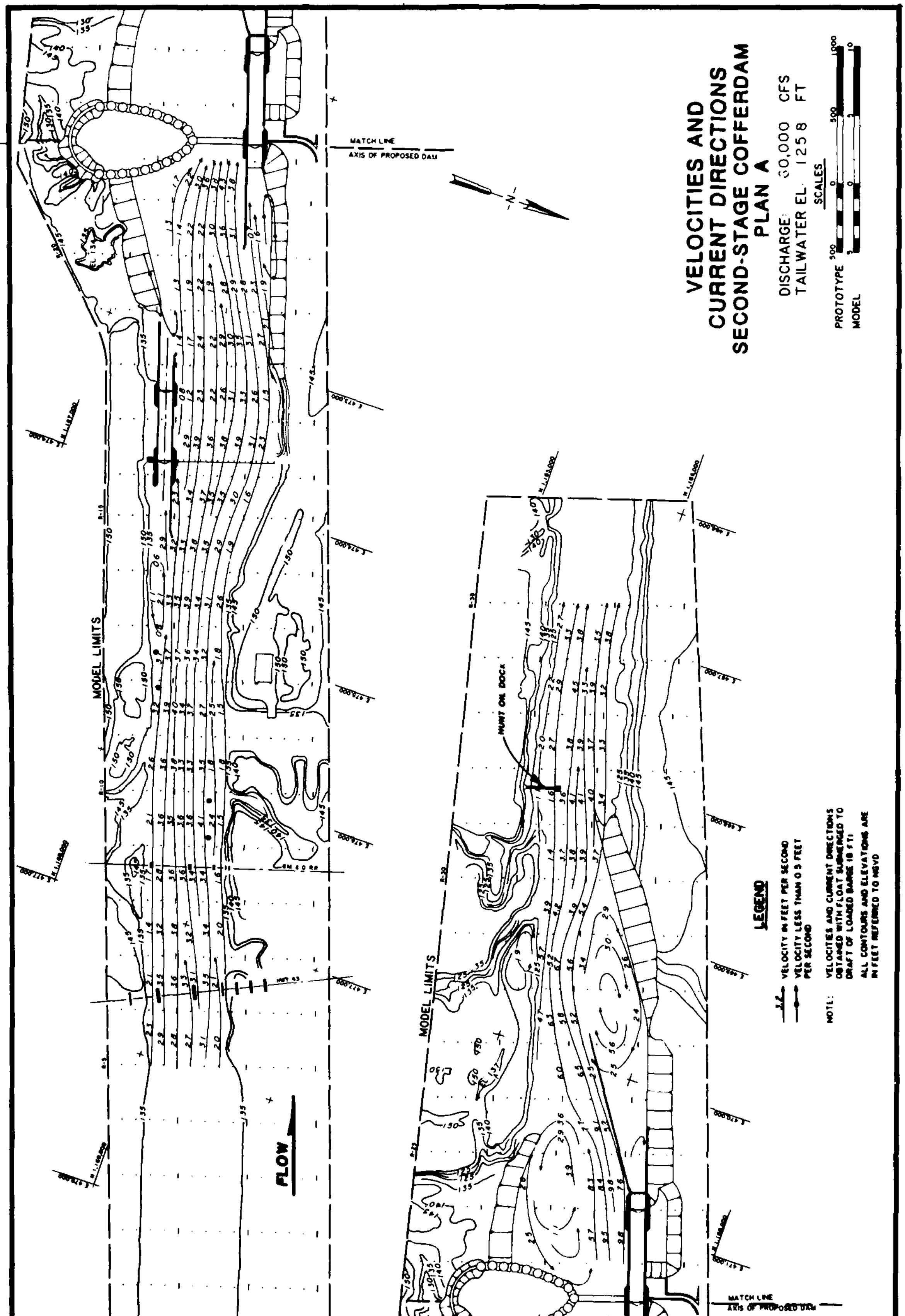
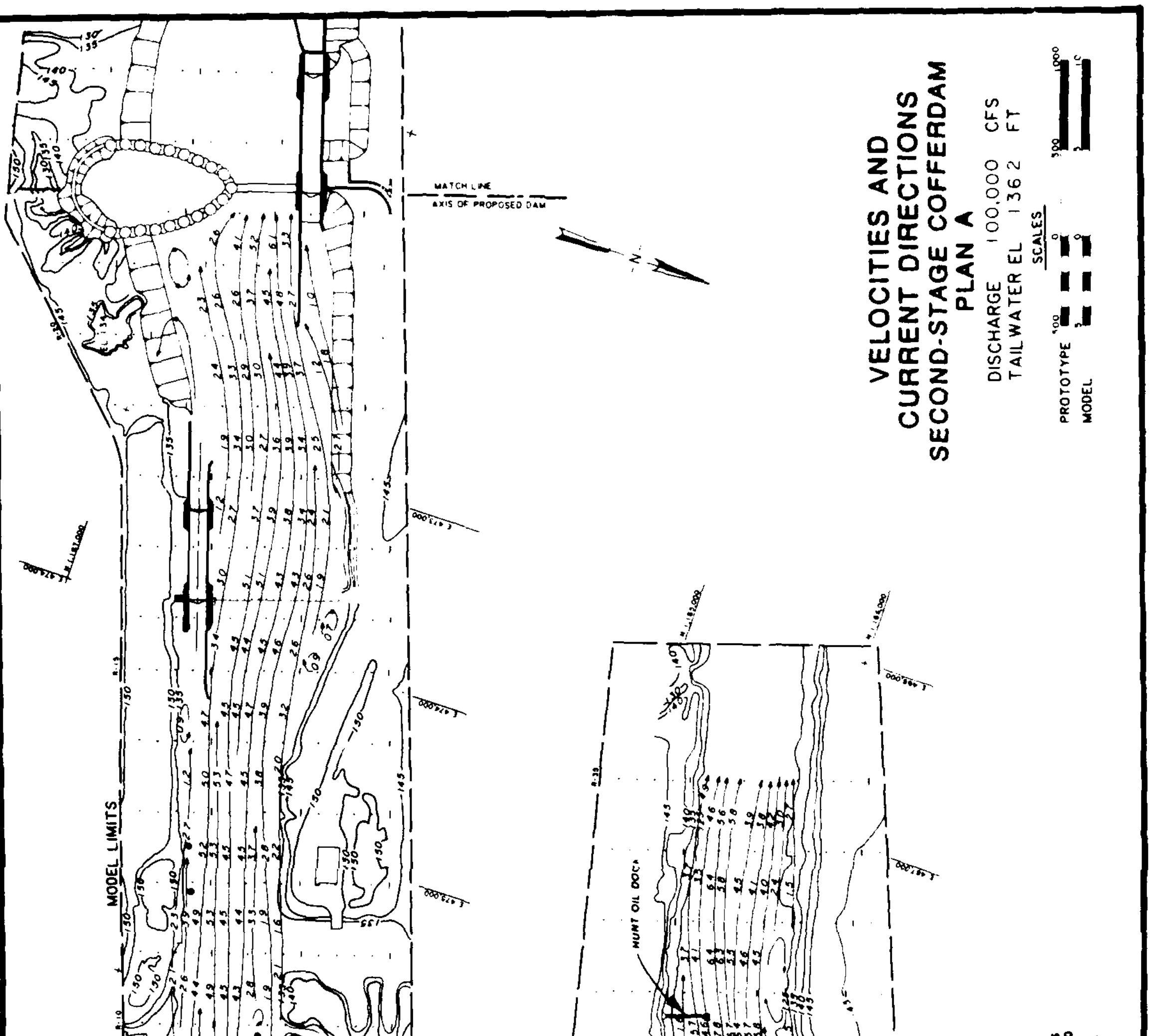
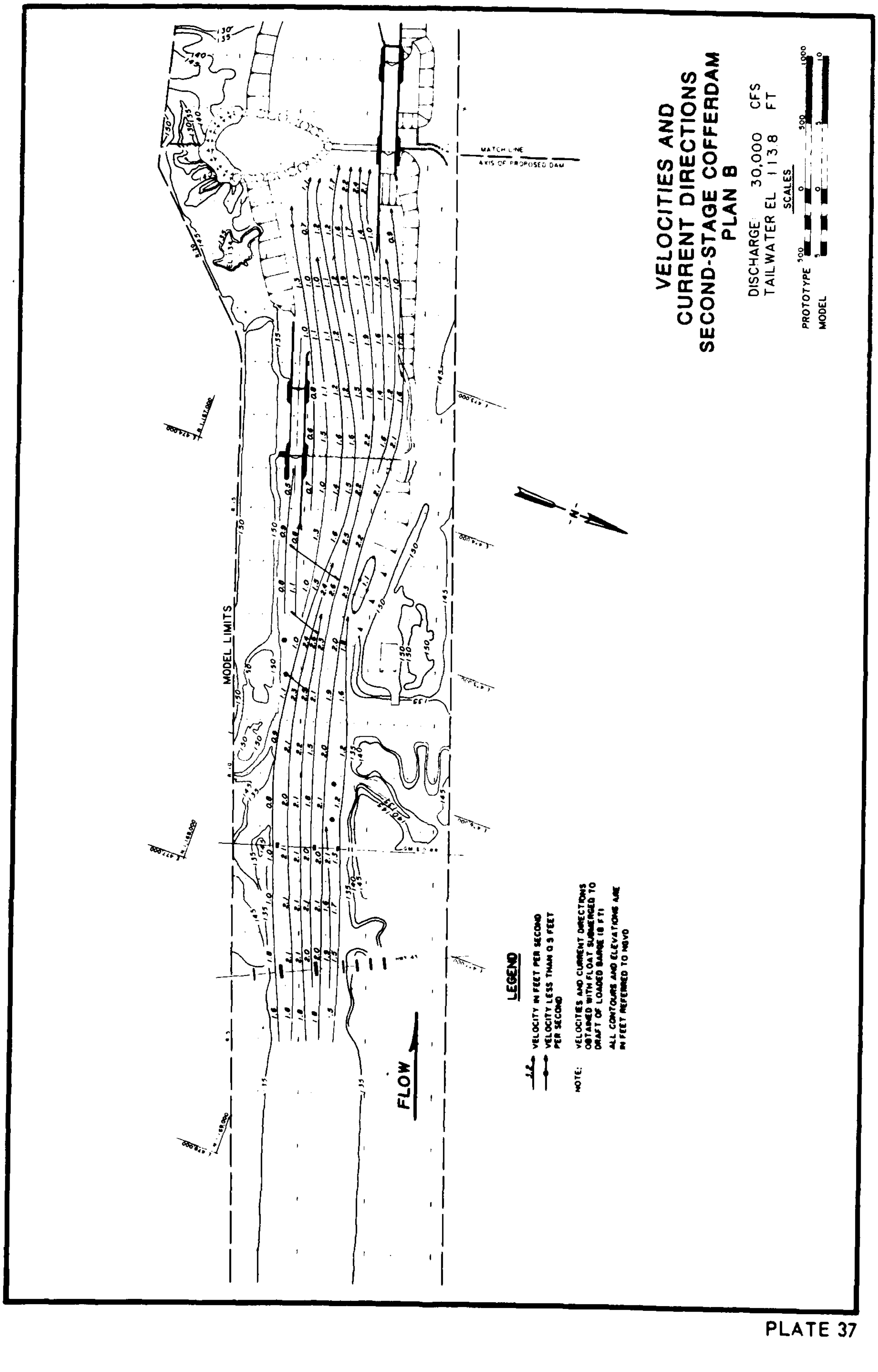
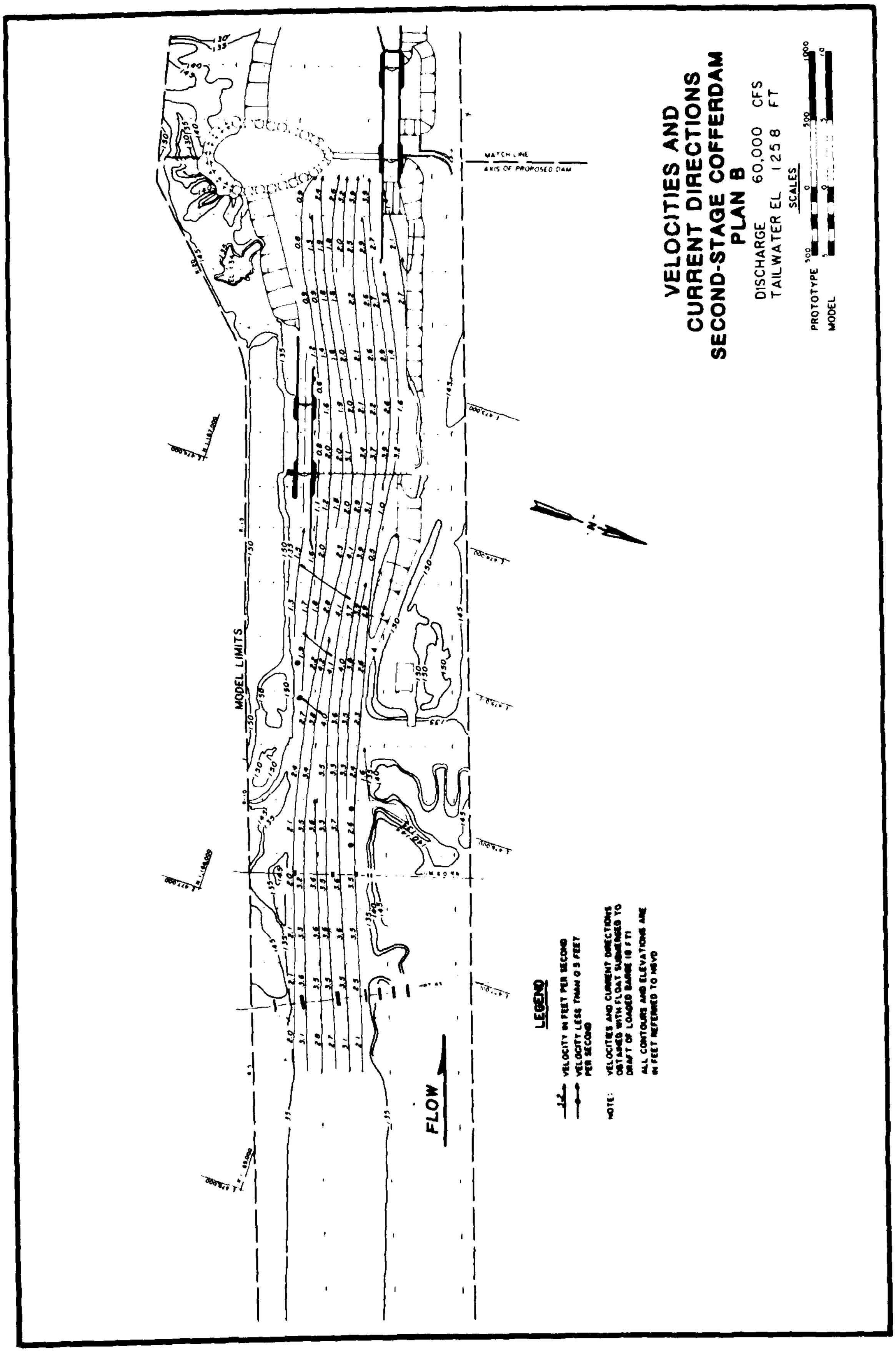

VELOCITIES AND
CURRENT DIRECTIONS
SECOND-STAGE COFFERDAM
PLAN A
DISCHARGE 30,000 CFS
TAILWATER EL. 125.8 FT
SCALES
PROTOTYPE
MODEL
MODEL LIMITS
MATCH LINE
AXIS OF PROPOSED DAM
HUNT OIL DOCK
FLOW
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

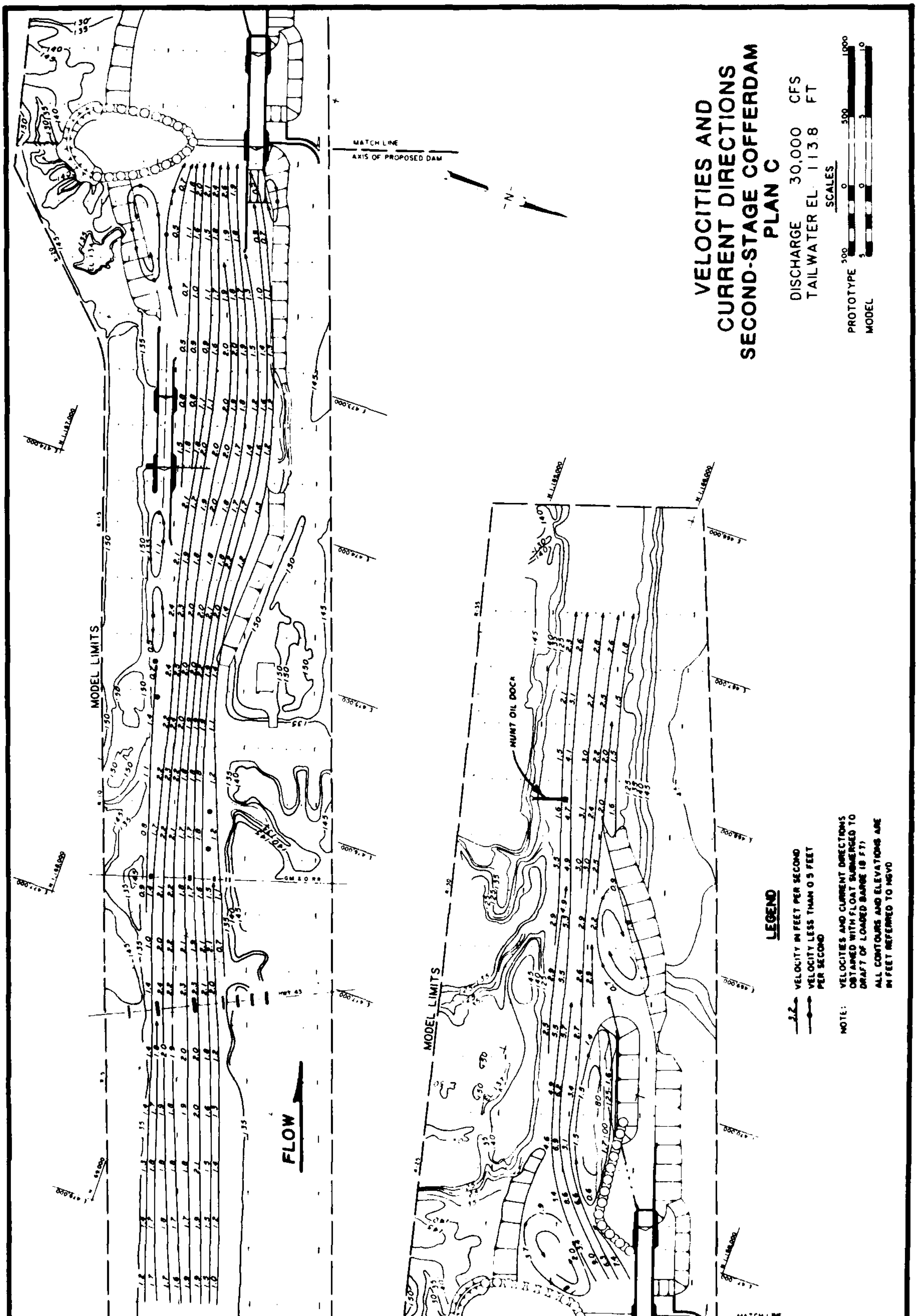
PLATE 35


VELOCITIES AND
CURRENT DIRECTIONS
SECOND-STAGE COFFERDAM
PLAN A
DISCHARGE 100,000 CFS
TAILWATER EL 136.2 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
MATCH LINE
AXIS OF PROPOSED DAM
HUNT OIL DOCK
FLOW
N


VELOCITIES AND
CURRENT DIRECTIONS
SECOND-STAGE COFFERDAM
PLAN B
DISCHARGE 30,000 CFS
TAILWATER EL 1138 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
FLOW
MODEL LIMITS
MATCH LINE
AXIS OF PROPOSED DAM



VELOCITIES AND
CURRENT DIRECTIONS
SECOND-STAGE COFFERDAM
PLAN B
DISCHARGE 60,000 CFS
TAILWATER EL 125.8 FT
SCALES
PROTOTYPE
MODEL
MODEL LIMITS
MATCH LINE
AXIS OF PROPOSED DAM
FLOW
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD



VELOCITIES AND
CURRENT DIRECTIONS
SECOND-STAGE COFFERDAM
PLAN C
DISCHARGE 30,000 CFS
TAILWATER EL 113.8 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MATCH LINE
AXIS OF PROPOSED DAM
MODEL LIMITS
FLOW
HUNT OIL DOCK
N

PLATE 39

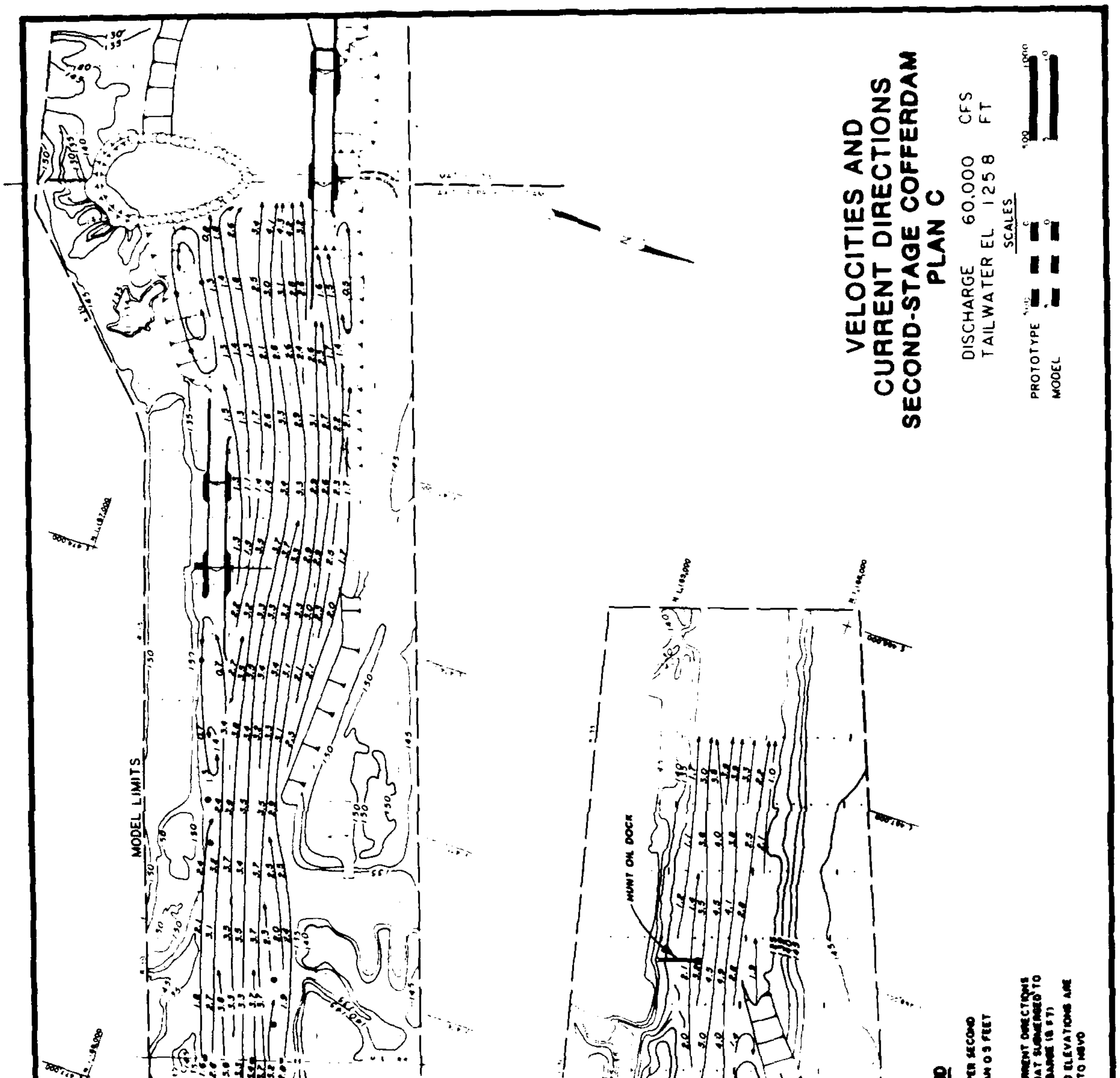
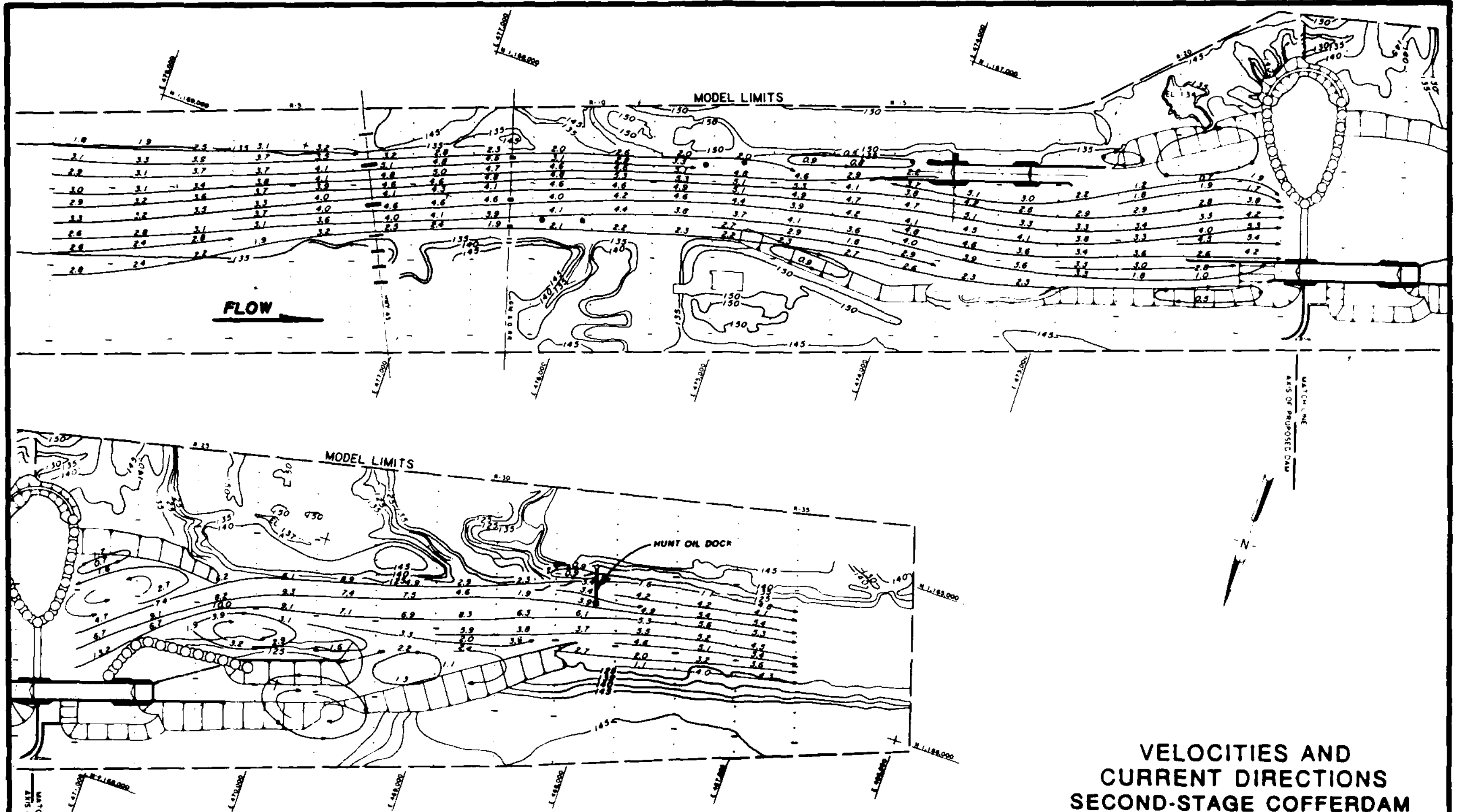

VELOCITIES AND
CURRENT DIRECTIONS
SECOND-STAGE COFFERDAM
PLAN C
DISCHARGE 60,000 CFS
TAILWATER EL 125.8 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.3 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
HUNT OIL DOCK
FLOW
MATCH LINE
AXIS OF PROPOSED DAM

PLATE 40



VELOCITIES AND CURRENT DIRECTIONS SECOND-STAGE COFFERDAM PLAN C

DISCHARGE 100,000 CFS
TAILWATER EL 136.2 FT

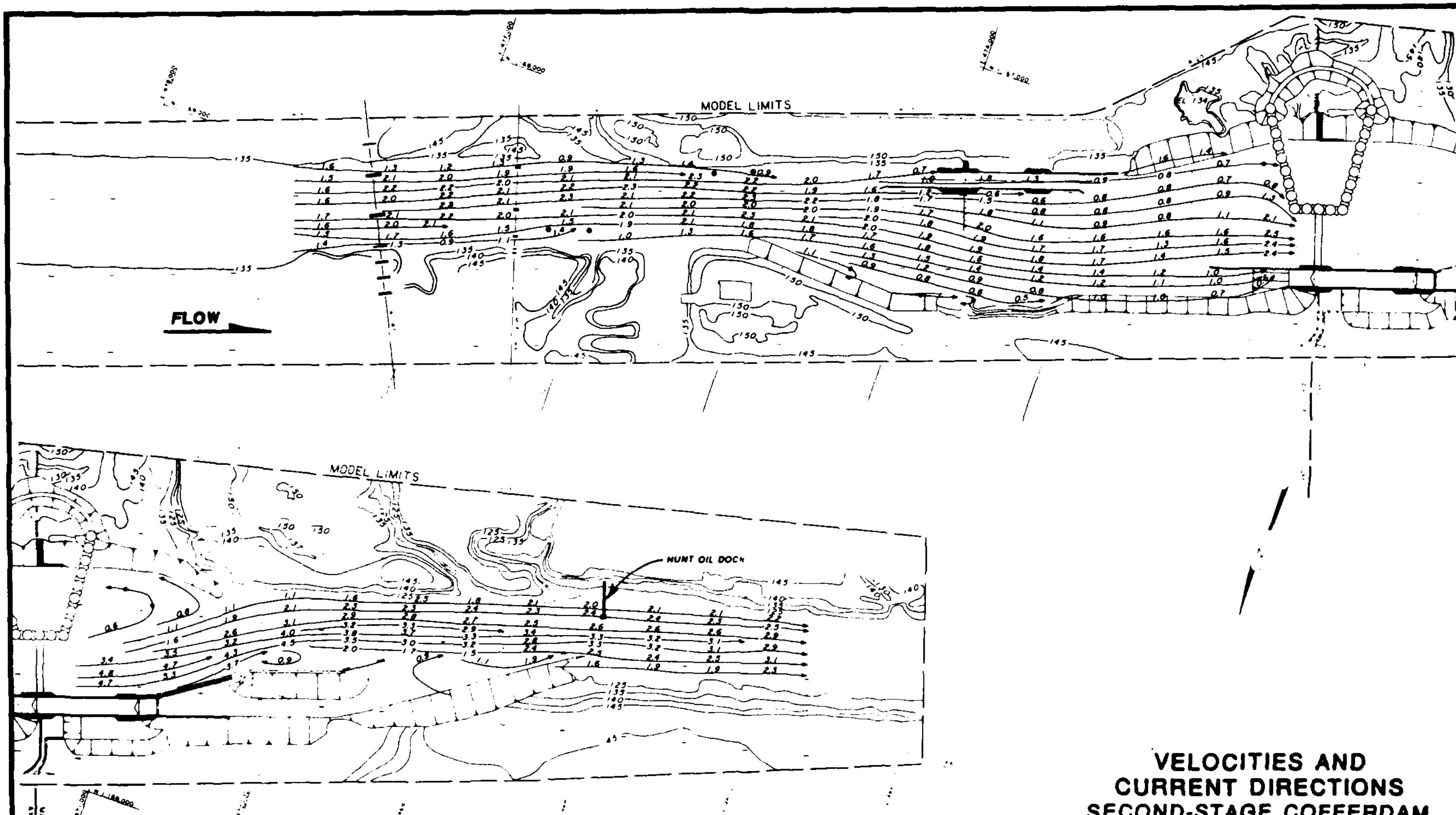
SCALES

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

LEGEND

3.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD



LEGEND

1.2 VELOCITY IN FEET PER SECOND

VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS SECOND-STAGE COFFERDAM PLAN D

DISCHARGE 30,000 CFS
TAILWATER EL 113.8 FT

SCALES

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

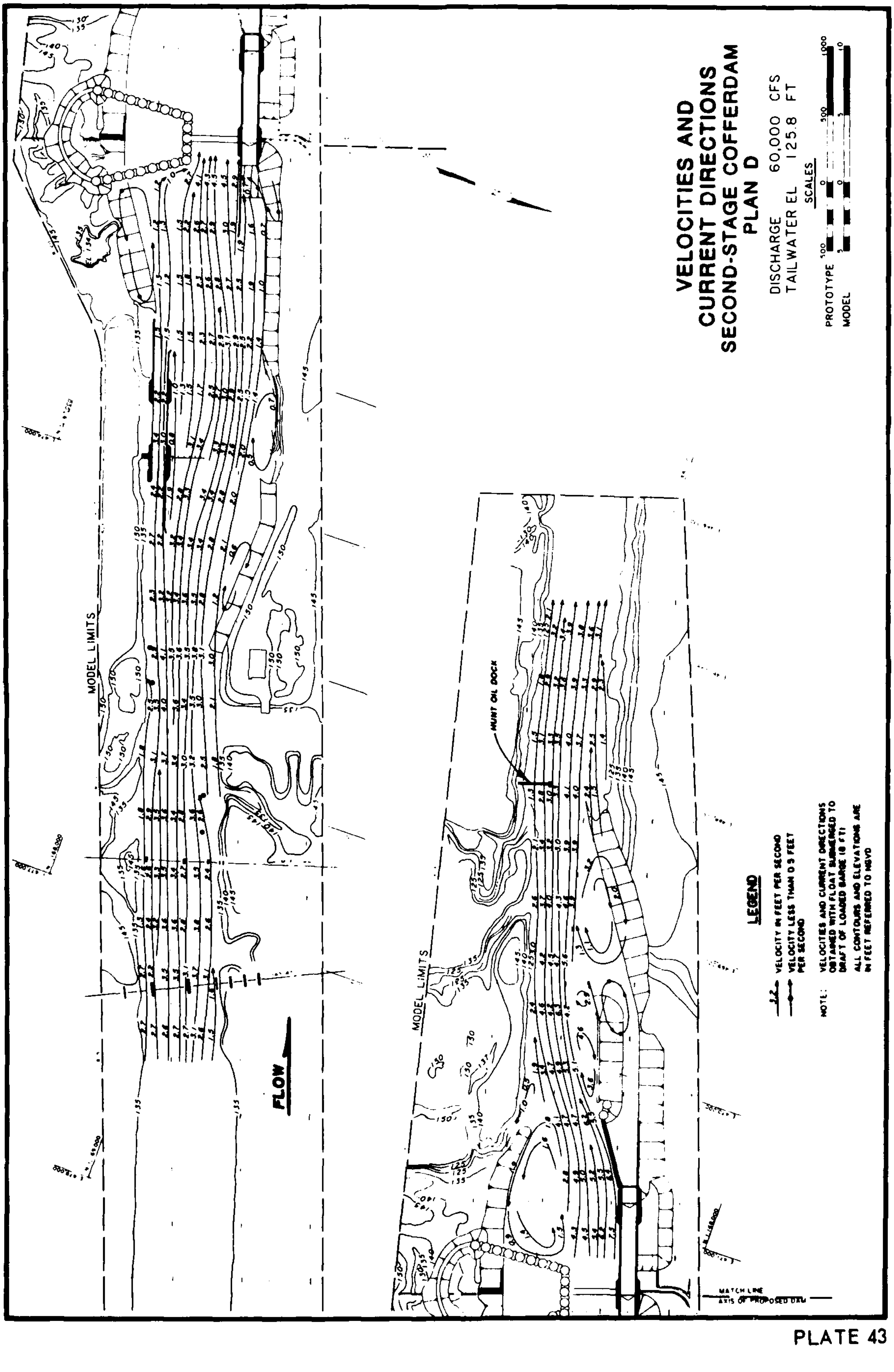
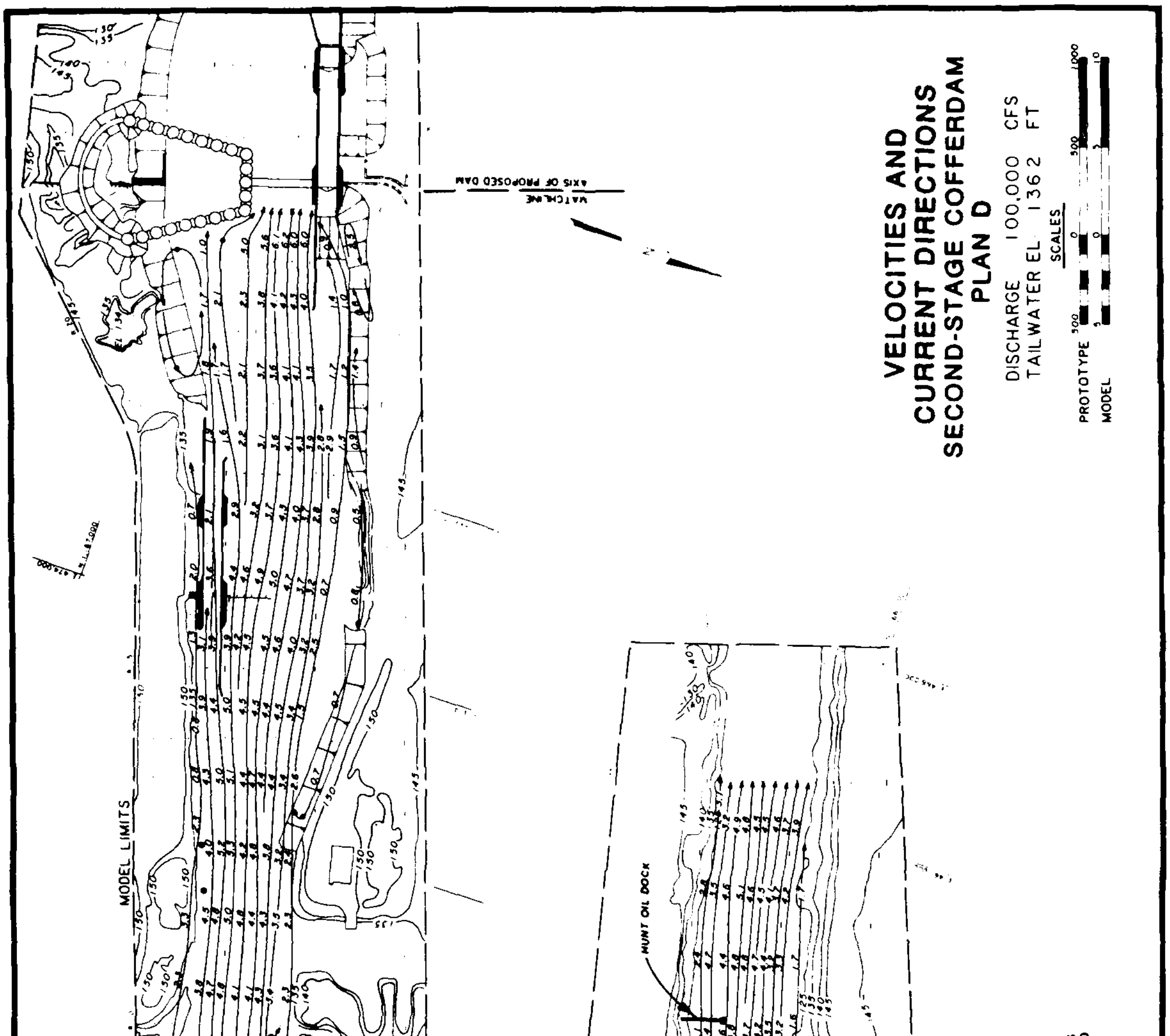

VELOCITIES AND
CURRENT DIRECTIONS
SECOND-STAGE COFFERDAM
PLAN D
DISCHARGE 60,000 CFS
TAILWATER EL 125.8 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
FLOW
HUNT OIL DOCK
MATCH LINE
AXIS OF PROPOSED DAM

PLATE 43


VELOCITIES AND
CURRENT DIRECTIONS
SECOND-STAGE COFFERDAM
PLAN D
DISCHARGE 100,000 CFS
TAILWATER EL 136.2 FT
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
FLOW
HUNT OIL DOCK
MATCHLINE
AXIS OF PROPOSED DAM